

AN EVALUATION STUDY
OF TWO NONLIMITED ACCESS
BY-PASSES IN INDIANA

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LAFAYETTE INDIANA

by

Charles
Pinnell

FINAL REPORT

AN EVALUATION STUDY OF
TWO NONLIMITED ACCESS BY-PASSES IN INDIANA

TO: K. B. Woods, Director
Joint Highway Research Project

January 30, 1958

FROM: H. L. Michael, Assistant Director

File: 3-3-26

Project: C-36-542

This will transmit a final report entitled, "An Evaluation Study of Two Nonlimited Access By-Passes in Indiana." The report has been prepared by Mr. Charles Pinnell under the direction of Harold L. Michael. Mr. Pinnell also utilized this report as his thesis in partial fulfillment of the requirements for the M.S.C.E. degree.

The study is a re-evaluation of the Kokomo and Lebanon by-passes--this time after approximately five years of operation. The deterioration of several characteristics of the by-passes is shown to be a result of the lack of limited access. A study of the accidents on these by-passes in the past several years is especially interesting.

Respectfully submitted,

Harold L. Michael
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File: 3-3-26
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January 30, 1958

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Thanks are extended to the personnel of the Indiana State Police who greatly aided in the accident studies and to the city and county officials in Kokomo and Lebanon who provided information on various aspects of the study.

The author is also grateful to the Joint Highway Research Project for the use of its facilities, equipment and part-time student help which made this project possible.



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ABSTRACT

Pinnell, Charles. M.S.C.E., Purdue University, January, 1958.

An Evaluation Study of Two Nonlimited Access By-Passes in Indiana.

Major Professor: Harold L. Michael.

The purpose of this study was to evaluate the operational efficiency of nonlimited access by-pass facilities and to determine the long-range economic effects of highway by-passes upon communities through which they pass. Travel times and accident rates were used as a criteria of efficiency and the economic effects were studied in terms of the effects on land values, land use and business.

Travel-time data were obtained from travel-time studies performed on each of the by-passes and accident data were obtained from the records of the Indiana State Police. Land use maps were prepared from data recorded in previous studies, from aerial photographs and from field studies. The data for evaluating land values were obtained from available records, previous studies and interviews with competent real estate dealers in the affected communities. Business data were obtained by personal interviews with businessmen.

The study revealed that the operational efficiency of nonlimited access by-passes is very inadequate and that the observed increase in travel times and a large percentage of the accidents on the by-pass were due to the lack of access control. Also, it was found that the long-range economic effects of by-passes are very beneficial.

AN EVALUATION STUDY
OF TWO NONLIMITED ACCESS BY-PASSES
IN INDIANA

INTRODUCTION

The future of the American highway system depends upon the ability of the highway engineer to design and build highways which will meet the functional requirements of safe and rapid movement. The mounting accident toll and the increasing congestion and delay encountered on our highways testify to the inefficiency of our highway facilities and to their inability to perform the essential functions for which they were designed.

One of the most difficult tasks facing highway engineering today is that of providing for the efficient movement of large volumes of through traffic in and around urban areas. The bottleneck of congestion and delay which confronts highway traffic in urban areas must be broken if an adequate transportation system is to be developed.

This task is complicated by the conflicting characteristics of local and through traffic as the infusion of high-speed through traffic with low-speed, frequent-turning local traffic lends itself to the development of serious accident and congestion problems. In addition, proposed highway improvements in urban areas are often faced with serious opposition from local groups who fear the economic effects of new or improved highway facilities.

One approach to the problem has been the construction of highway by-passes. Many of these highways, defined as a facility for the purpose of diverting through traffic from a particular area by taking traffic around or passing it by the area, have been built throughout the country to aid the movement of through traffic in urban areas. The majority of these facilities, however, have placed no restriction on access, which has allowed the development of roadside business and has permitted the use of the facility as a local street. As a consequence, the ability of these facilities to move through traffic has rapidly deteriorated.

Traffic accidents are very important in the humanitarian and economic aspect and are an index of the efficiency of a highway facility. Rapid movement is also an important measurement of highway efficiency and no by-pass could justly be termed efficient that does not provide for both safe and rapid movement. Unfortunately, much of the present design of by-pass facilities does not provide for both of these but, in most cases, one has been sacrificed in an effort to obtain the other. Rapid movement on nonlimited access facilities often results in high accident rates which in turn demand restricting regulations and traffic controls that create delay and congestion.

This need for increased operating efficiency and permanence of design has introduced the development and use of the modern controlled access highway. This facility, incorporating the features of limited access, multi-lanes, divisional median and elimination

of at-grade intersections, is designed specifically to provide for the movement of through traffic. The essential features of limited access and elimination of at-grade intersections provide for the separation of through and local traffic and the elimination of the marginal friction caused by vehicles entering and leaving the traffic stream at various access points. Several years of use throughout the United States have demonstrated the ability of these facilities to provide for safe and rapid movement.

There are those, however, who would oppose the use of controlled access by-pass facilities. They propose that nonlimited access facilities can serve both local and through traffic efficiently and are more economical due to a smaller initial cost. Thus, the need has developed for the accumulation of data to indicate the inefficiency and inadequacy of nonlimited access by-passes to perform the function for which they were built. By studying the past operation of by-pass facilities, valuable experience to guide future design and construction is obtained.

Though the provision of safe and efficient movement is essential, highway facilities should not pose a detrimental effect to the economy of the communities through which they pass. The highway engineer and planner must also concern himself with the economic effects of by-passes and seek means of evaluating these effects. Here again, existing facilities can provide valuable sources of information.

Generally, a highway facility built in an urban area will have an economic effect on the following: (1) land use in the vicinity of the facility, (2) land value in the area of the facility and (3) business in the by-passed community. These effects are of vital importance to the economic welfare of a community and cause just concern among its citizens. Therefore, data on the effects are essential to the proper planning and location and to the public acceptance of future by-pass facilities. These data can also broaden the base for predicting benefits of future facilities.

PURPOSE

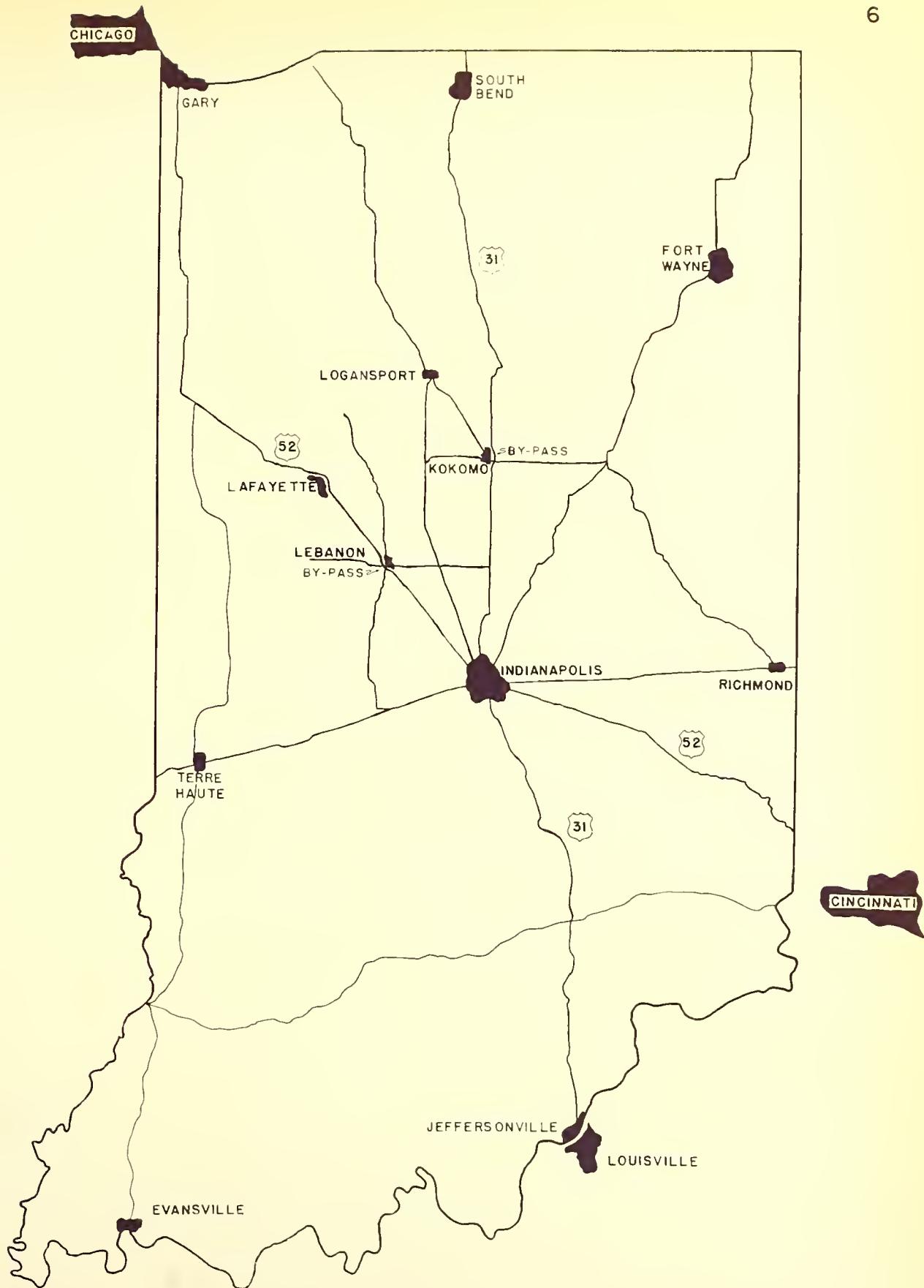
The purpose of this study was to evaluate the operating efficiency and the economic effects of two nonlimited access by-passes located at Lebanon and Kokomo, Indiana.

PREVIOUS STUDIES

In August, 1950, the Advisory Board of the Joint Highway Research Project at Purdue University approved plans for a study of the economic and traffic aspects of the Lebanon and Kokomo by-passes. These studies were performed during the period September, 1950, to July, 1951. Since both by-passes were under construction and completed during this period, studies were made "before" and "after" the facilities were opened to traffic. The location of these cities with respect to the Indiana highway system is shown in Figure 1 and the location of the by-passes at Kokomo and Lebanon are shown in Figures 2 and 3, respectively. Kokomo is a city with a present population of 44,100 while Lebanon has a population of 9,023.

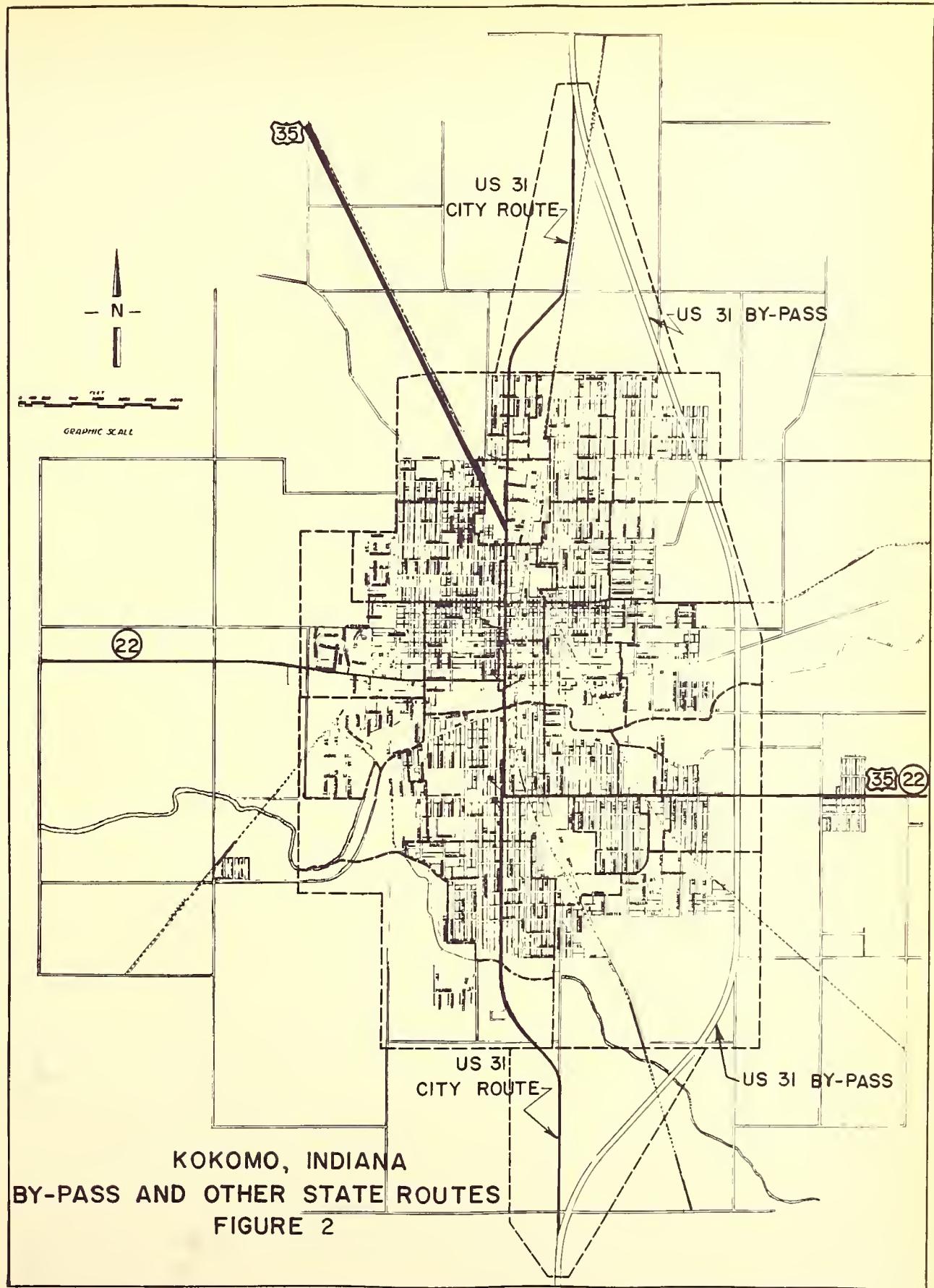
Traffic data were obtained by two external-type, origin-and-destination surveys and supplementary volume counts conducted at each location. One of the O - D surveys, the "before" study, was conducted prior to the completion of each by-pass and the second, the "after" study, was performed approximately six months after each by-pass had been opened to traffic. The standard information for an origin-destination study was obtained and this information, along with volume count data, was used in the analysis and comparison of the traffic pattern for the "before" and "after" periods.

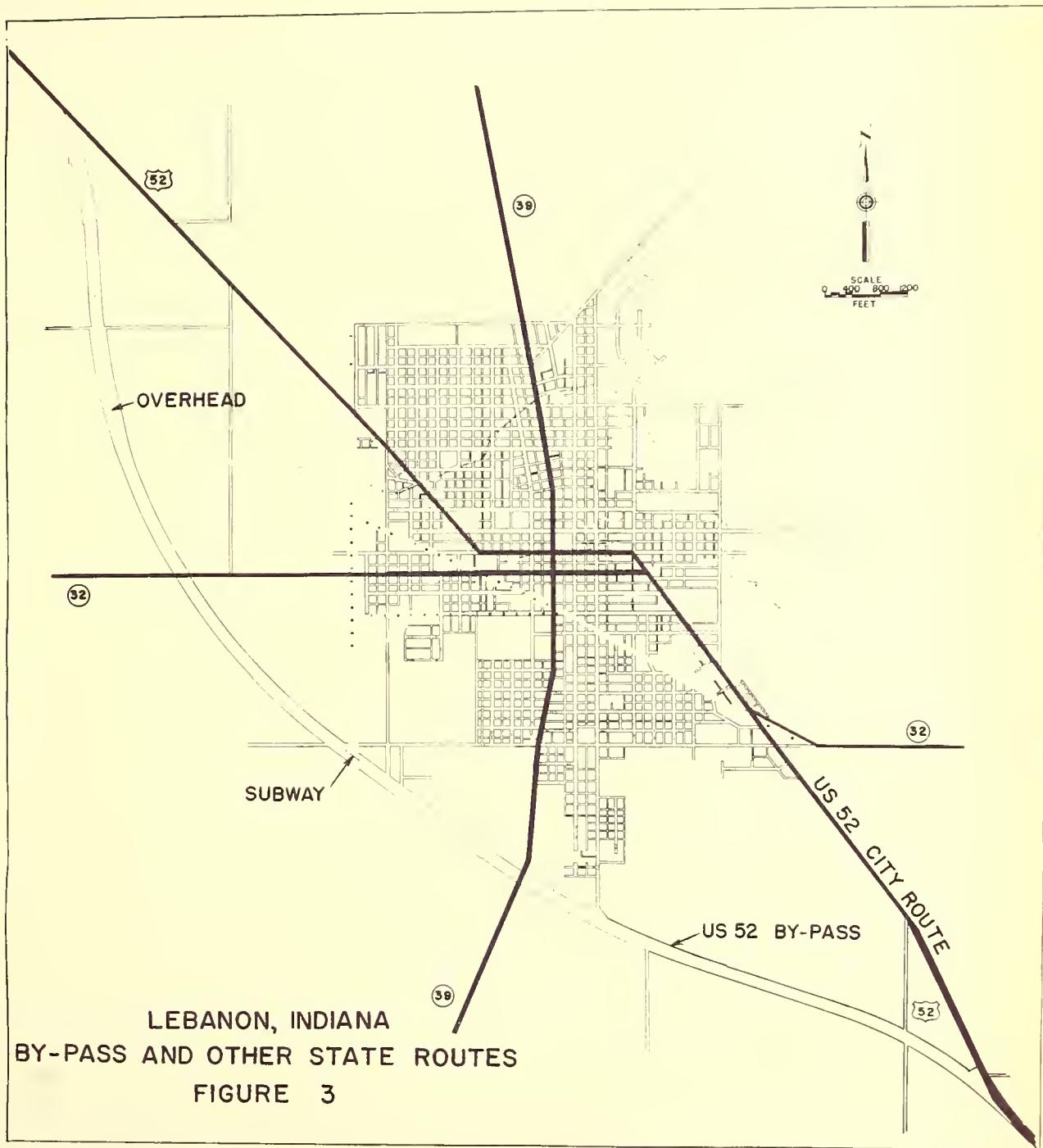
From the "before" studies, it was determined that 22 percent (approximately 1300 vehicles per day) of the traffic approaching Kokomo and 59 percent (approximately 4000 vehicles per day) of the



PRINCIPLE HIGHWAY ROUTES IN INDIANA

FIGURE 1





traffic approaching Lebanon desired to pass through the city (8)*. The "after" studies indicated that the by-passes did an effective job of routing the through traffic around each town with 82 percent of the through traffic at Kokomo and 94 percent of the through traffic at Lebanon using the by-pass. Traffic data also indicated that the by-passes were serving as distributor facilities for local traffic. This use was quite large for the Kokomo by-pass.

Travel-time studies were conducted during the "before" and "after" periods and benefits to the through motorist in terms of reduced operating costs and time savings were determined. From these data a benefit-cost ratio of 1.65 for the Kokomo by-pass and 2.61 for the Lebanon by-pass was computed.

In addition to the traffic data, information concerning the effect of the by-passes on land value, land use, accidents and business was collected. These data indicated that the by-passes did have a significant effect on these items but the scope of these studies was limited by a relatively short "after" period of approximately six months. Since it was felt that a longer "after" period would be necessary to fully evaluate these effects, it was recommended that a follow-up study be made at a later date. This report fulfills those recommendations.

*Numbers in parenthesis refer to bibliography

PROCEDURE

A period of approximately six years has elapsed since the completion of the previous studies and the beginning of this study. It is believed that this is a sufficient length of time to allow for significant changes in land use, land values and business and is a satisfactory period over which to evaluate the long-range economic effects and operating efficiency of the facilities.

Travel Time Study

To obtain one measure of operating efficiency, it was desirable to study travel times and over-all vehicle speeds on both by-passes. These data were used to evaluate present operating efficiency and also compared with results recorded in the previous studies to indicate the deterioration that has occurred.

Since the average car method of obtaining travel times was used in the previous studies, it was again used so that results of the two studies would be comparable. This method consists of a series of runs made over the route being studied at different periods of the day. During the runs, the driver of the test car travels at a speed which, in his opinion, is representative of the speed of traffic on the facility at that time. Total travel time, total distance and information on the cause and duration of delays are observed and recorded during the run.

The study was facilitated by the use of a Streetor-Amet Travel-time and Distance Recorder. This instrument, pictured in

Figure 4, consists of a timer, distance wheel and a printing mechanism and is designed to permit automatic recording of data on travel times, distances and causes of delay. A roll of paper moves through the recorder and the readings on electrically operated counters set below the paper can be recorded on this paper by pressing a print button. A timer is wired to one printing counter and the counter advances one hundred numbers each minute. A second counter is actuated by a speedometer cable connected to the cable of the test car. This counter permits recording of distance to the hundredth of a mile. A third counter, which reads from 1 to 12, is actuated by a rotary solenoid which is controlled by a set of numbered keys on a control panel. This counter is used to code the data on the other two counters.

This recorder is mounted in the test car as shown in Figure 5 and can be operated by the driver or by a second observer. The driver then proceeds to make the run and data on travel-time, distances, and cause and duration of delays are recorded and printed automatically on the tape during the course of the run.

Figure 6 shows a sample data sheet for a test run.

In order to determine how the average speed varied over different sections of the route, the by-passes were divided into several sections by the selection of control points at the beginning and end of each section. These control points are shown in Figure 14 for the Kokomo by-pass and Figure 15 for the Lebanon by-pass. As the test car passed a control point, time and

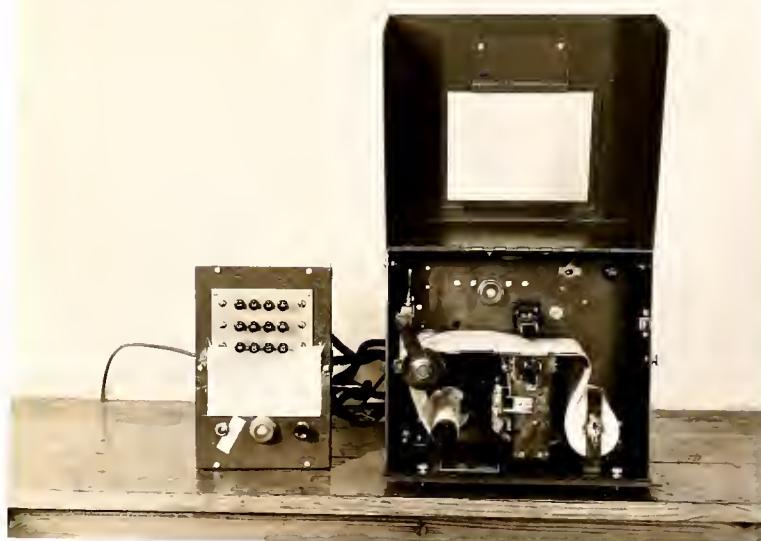


Figure 4. Streetor-Amet Travel-time and
Distance Recorder



Figure 5. Recorder Mounted in Test Car

		TIME TO $\frac{1}{100}$ OF MINUTE					DISTANCE TO $\frac{1}{100}$ OF MILE			
CODE COLUMN										
END OF RUN	→	3	0	0	9	2	9	0	7	3
		3	0	0	9	2	6	0	7	3
		4	0	0	8	0	2	0	6	2
		2	0	0	7	0	0	0	5	3
		4	0	0	6	5	0	0	5	0
END SIGNAL		1	0	0	5	5	8	0	4	4
DELAY	→	0	0	0	5	5	0	0	4	3
BEGINNING STOPPED	→	5	0	0	5	2	2	0	4	3
TIME DELAY	→	2	0	0	4	5	4	0	3	0
		2	0	0	4	0	4	0	3	5
CONTROL POINT	→	4	0	0	3	7	3	0	3	2
		2	0	0	2	8	0	0	2	3
		2	0	0	2	2	0	0	1	7
		2	0	0	1	6	3	0	1	2
		4	0	0	0	7	5	0	0	8
START RUN	→	3	0	0	0	4	0	0	0	2

DATA TABULATION

CONTROL	DISTANCE	TIME	SPEED
0-4	1.58	1.80	52.7
4-3	1.46	1.53	57.2
3-2	1.78	2.77	38.6
2-1	1.26	1.52	49.7
1-0	1.04	1.27	49.1

OVER-ALL DISTANCE 7.12
 OVER-ALL TIME 8.89
 OVER-ALL SPEED 48.10

FIGURE 6 SAMPLE OF TRAVEL TIME DATA

distance to that particular point were recorded and from these data speeds over the various sections were calculated. The duration and causes of delays encountered on each run were also recorded. A minimum of 14 test runs was conducted on each by-pass.

Accident Study

In order to further evaluate the efficiency of the by-passes and to determine the extent that the lack of access control was contributing to accidents, a study was made of the accidents that occurred on both by-passes. Accidents on the Kokomo by-pass were studied for a period from January 1, 1953 to June 30, 1957 and accidents on the Lebanon by-pass were studied for a period from January 1, 1952 to June 30, 1957. All accidents were obtained from the files of the Indiana State Police.

The accident reports for all reported accidents on the by-passes for the periods indicated were examined and the following data tabulated for each accident:

Date of Accident
Type of Accident
Time of Accident
Estimated Property Damage
Number of Vehicles Involved
Location of Accident
Brief Description of Accident

These data were then analyzed and all pertinent information was extracted.

Land Use Study

Land use in the area of the by-passes was obtained from a study of previous data, air photos and field observation. Data on land use along the by-passes for periods before and after the construction of both by-passes were obtained from previous studies, and data on present land use were obtained from aerial photographs and field observations. The data for all pertinent periods were then used to prepare land use maps of the by-pass areas.

Land Value Study

Data on land values for this study were obtained from reliable real estate dealers in Kokomo and Lebanon. A list of such dealers was compiled and then these men were interviewed personally to obtain the desired information. Data on land value in specific transactions were sought rather than the dealers opinion of land values.

It was originally planned that the land value study would gather data from three different sources. These sources were as follows: (1) records of the County Assessor, (2) records of the County Recorder and (3) real estate dealers. After considerable study, however, it was determined that the first two sources did not present a consistent and reliable source of information.

The last general assessment of land values was made in 1949 and the records had not been changed to represent present values.

Thus, it was impossible to obtain any data regarding land value changes from the records of the County Assessor.

The second source of land value information considered was from warranty deeds filed in the office of the County Recorder. Revenue stamps are placed on warranty deeds in an amount corresponding to the reported cash value of the transaction. It is then possible to calculate the reported amount of the sale from the value of the revenue stamps.

A study of several tracts revealed, however, that very frequently the land value calculated from the amount of the revenue stamps was lower than the assessed value of the property. Since the person conducting the transaction is not required to produce evidence of the sale value, he can report any price that he desires. Considering this information, it was reasoned that this source was entirely unreliable.

Since the population of Kokomo, Indiana, has increased significantly during the period of the study, it was believed that some control was necessary to evaluate the over-all economic effect of this population growth. To provide this control, a residential area on the west side of Kokomo was selected to use as a comparison with the by-pass area. This area is shown in Figure 31. Land values for both the by-pass area and this control area were then studied and compared for different periods of time.

Business Study

Factual information on the effect of highway facilities on business in a community is very difficult to obtain. Other states, in studies of this sort, have utilized sales tax records, but since Indiana has no sales tax, the only probable source of factual information regarding business is the records of the Gross Income Tax Division. Efforts to obtain data from this source have met with no success.

As a secondary source of information on business effects, a survey of business along the former routes through the towns was conducted by means of personal interviews. Businessmen who had conducted a business along these routes before and after the opening of the by-pass were interviewed and information regarding the effect of the by-pass on their business and their attitude toward the by-pass were recorded. An interview form of the type shown in Figure 7 was used.

Date of Interview _____

By-Pass _____

Business Name _____

Location of Business _____

Type of Business _____

How Long in Present Location _____

Position of Interviewee _____

Do you feel that the By-Pass
has affected your Business _____

Increase or Decrease _____

Were you in favor of the By-Pass
when it was proposed _____

Are you in favor of it now _____

Remarks _____

Figure 7. Sample Interview Form

OPERATIONAL EFFICIENCY

Travel Time

Travel-time studies conducted on the Lebanon by-pass indicated that during the approximately six and one-half years of operation, average travel-time over the by-pass route increased significantly. In 1951, six months after the opening of the by-pass, an average travel time of 5 minutes and 54 seconds was recorded for trips on the by-pass. Present average travel time is 6 minutes and 56 seconds (Figure 8). This increase of 1 minute and 2 seconds for average travel time represents a 25.7 percent loss in time savings to through traffic when compared to the average time saving of 4 minutes and 1 second recorded in 1951. Average speed has dropped from 52.4 miles per hour in 1951 to 44.5 miles per hour in 1957.

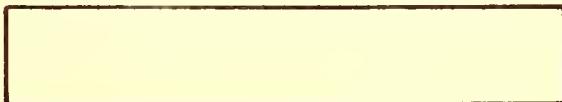
The indicated loss in operating efficiency on the Lebanon by-pass is directly attributable to the at-grade intersections of State Routes 32 and 39. In the spring of 1952, traffic signals were installed at the intersections of these routes with the by-pass in an effort to reduce traffic accidents at these locations. Travel times were greatly increased by these signals.

Though the traffic signals themselves only cause a 27 second stopped time delay to the average motorist, their over-all effect on travel times is more drastic. These signals require the driver to make a complete stop and, then release traffic in platoons of

U.S. 52 BY-PASS
1951

TIME: 5min 54sec SPEED: 52.4 mph

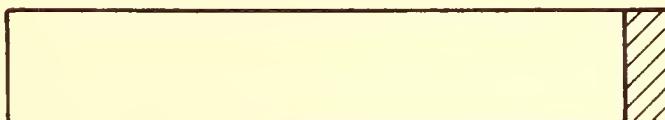
RUNNING TIME: 5min 54sec



U.S. 52 BY-PASS
1957

TIME: 6min 56sec SPEED: 44.5 mph

RUNNING TIME: 6min 29sec



STOPPED TIME: 27sec

FIGURE 8 TRAVEL TIME COMPARISONS LEBANON BY-PASS

several vehicles. This greatly delays truck traffic as it is difficult for them to regain their normal driving speed. The trucks, in turn, delay the faster accelerating automobiles as passing is difficult due to the platoon effect caused by the lights and restricted sight distance along the by-pass.

A plot of average speeds over different sections of the Lebanon by-pass is shown in Figure 9. Speeds are much higher on the end sections of the by-pass where there are no controls and fewer access points.

Travel time studies on the Kokomo by-pass revealed only a slight increase in average over-all travel time when compared to similar 1951 studies (Figure 10). The observed increase of 22 seconds in average over-all travel time could be mainly attributed to the stopped time delay caused by the traffic signal at the intersection of State Route 35 and the by-pass which has been installed since the previous study. Over-all average speed decreased from 49 miles per hour in 1951 to 47 miles per hour in 1957.

A great deal of delay and congestion is encountered on the section of the by-pass between Hoffer and Jefferson Streets. There are 28 access points, including five major streets, intersecting the by-pass in this section. As shown in Figure 11, average speeds are reduced to 39.2 miles per hour in this area. It appears, however, that motorists compensate for the delay encountered in this

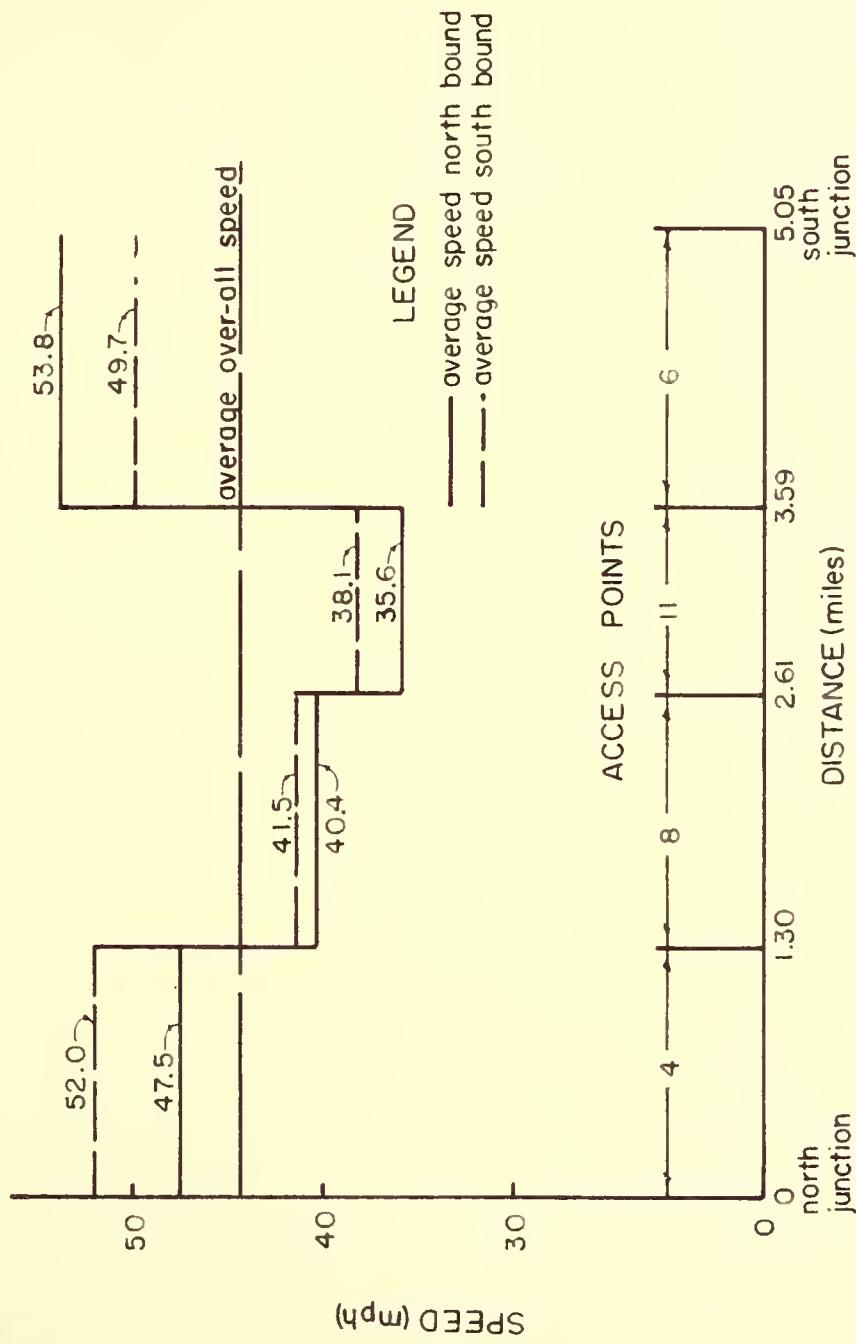


FIGURE 9 AVERAGE SPEED BETWEEN LOCATIONS ON LEBANON BY-PASS

U. S. 31 BY-PASS
1951

TIME: 8min 43sec

SPEED: 49.0 mph

RUNNING TIME: 8min 38sec



STOPPED TIME: 5sec

U. S. 31 BY-PASS
1957

TIME: 9min 05sec

SPEED: 47.0 mph

RUNNING TIME: 8min 46sec



STOPPED TIME: 19sec

FIGURE 10 - TRAVEL TIME COMPARISONS KOKOMO BY-PASS

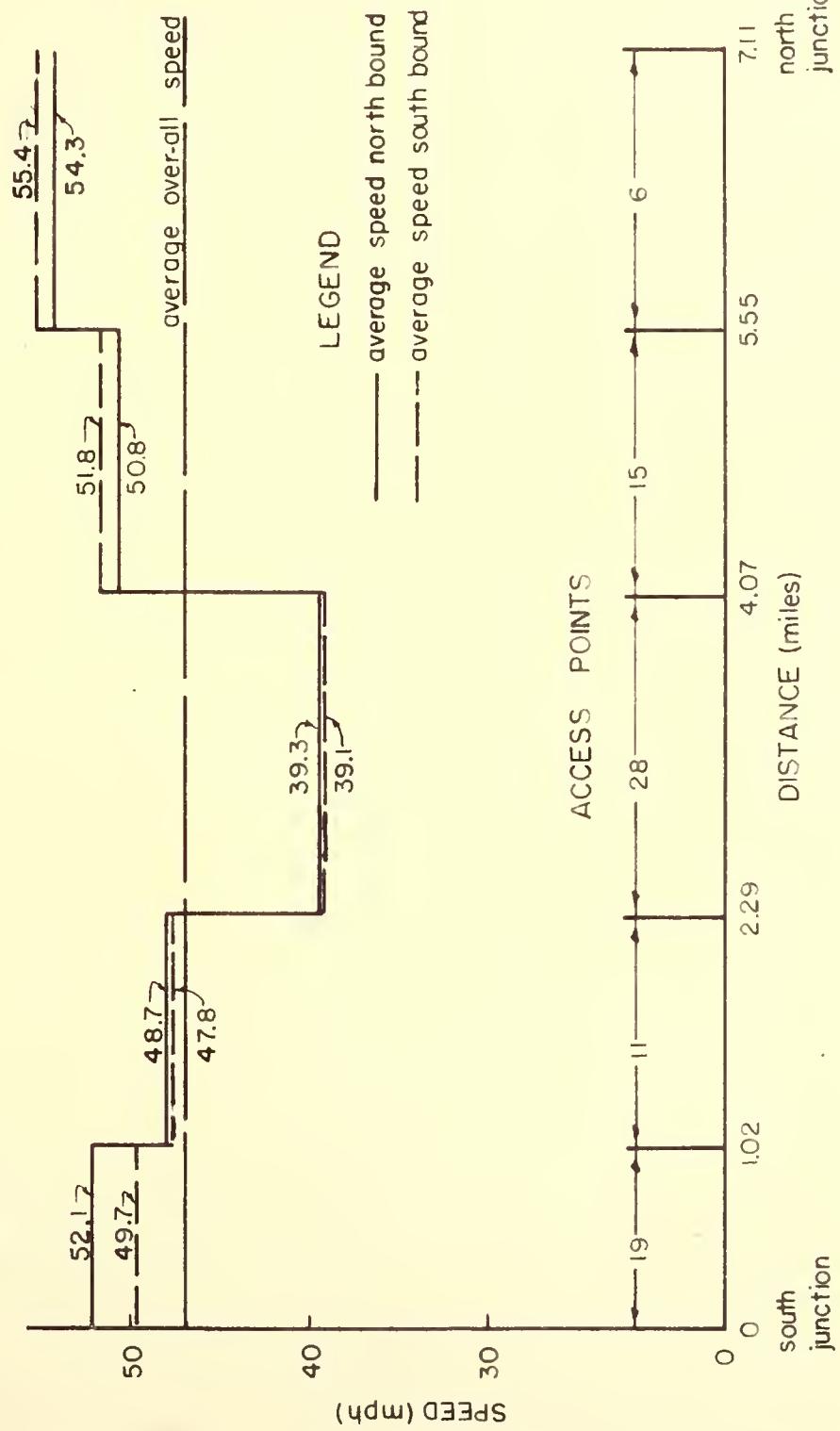


FIGURE II AVERAGE SPEED BETWEEN LOCATIONS ON KOKOMO BY-PASS

section by greatly increasing their speed over the end sections. Average speed in the two end sections are 54.8 miles per hour on the north end of the by-pass and 50.9 miles per hour on the south end of the by-pass.

Though the travel time has not increased greatly on the Kokomo by-pass, it has been maintained at the expense of a very high accident rate which will be discussed later. From discussions with public officials in Kokomo, it was learned that there is a growing public demand for additional traffic signals at points of high volume access to the by-pass. Police officers feel that a signal is needed at the intersection of Boulevard Avenue and the by-pass. This intersection serves traffic entering and leaving the parking lot of the Chrysler plant. They also feel that a traffic signal is needed at Sycamore Street to allow the heavy cross-town traffic to enter and leave the by-pass safely.

The demand for these signals is understandable in view of the accident rate, but their effect on the by-pass as a facility for the rapid movement of through traffic would be drastic. With the addition of these signals, the original five minutes and twenty seconds time saving to through traffic would be lost and the by-pass would become essentially just another city street.

Thus, after slightly over six years of operation, the Lebanon by-pass has suffered a 25 percent reduction in time savings to the through motorist and the Kokomo by-pass is in danger of an even

greater reduction in its time savings. With the present lack of access control on the facilities, this reduction can be expected to grow larger in the future.

Accidents

It has been said that most accidents are not accidents at all but are the result of direct causes. This is especially true of traffic accidents and an accumulation of such accidents indicates that something is wrong in the design or operation of a highway facility.

A study of the accidents on the Kokomo and Lebanon by-passes indicates that something is wrong on these facilities. During a five and one-half year period (1952 - 1957), a total of 235 accidents have occurred on the Lebanon by-pass. These accidents include 12 fatal accidents in which a total of 23 persons were fatally injured. The estimated economic loss, as stated on the accident reports, for property damage only was \$147,000.

A total of 339 accidents have occurred on the Kokomo by-pass over a four and one-half period of operation (1953 - 1957). A total of seven fatal accidents in which eight persons have lost their lives occurred during this period. Estimated property damage totals \$205,000.

In an attempt to relate accidents to the functional elements of the by-pass facilities so that inefficiencies in design would be apparent, all accidents were studied and classified as one of the following types:

Type I - Intersection accidents which occur at the crossing of two traffic streams. The accidents are typically right-angle, turning and rear-end collisions.

Type II - Marginal accidents which occur along the moving edge of a traffic stream. This accident results from vehicles attempting to get into or leave the moving traffic stream. Typical accidents are rear-end collisions.

Type III - Medial accidents which occur between vehicles moving in opposite directions. Head-on collisions and sideswipes are typical of this type accident.

Type IV - Internal-stream accidents which occur among vehicles moving in the same direction. This includes miscellaneous accidents such as running off the road, overturning, etc., and some rear-end collisions. This type of accident will occur on any facility.

This system of classification is recommended by Mr. Maxwell Halsey as being excellent for relating accidents to roadway design (11).

A tabulation of accidents by these types is shown in Table 1 for both the Lebanon and Kokomo by-passes.

Figures 12 and 13 indicate that accidents have been a problem since the opening of each by-pass. Thirty-three accidents on the Kokomo by-pass and twenty-seven on the Lebanon by-pass occurred during the first six months of operation. Average number

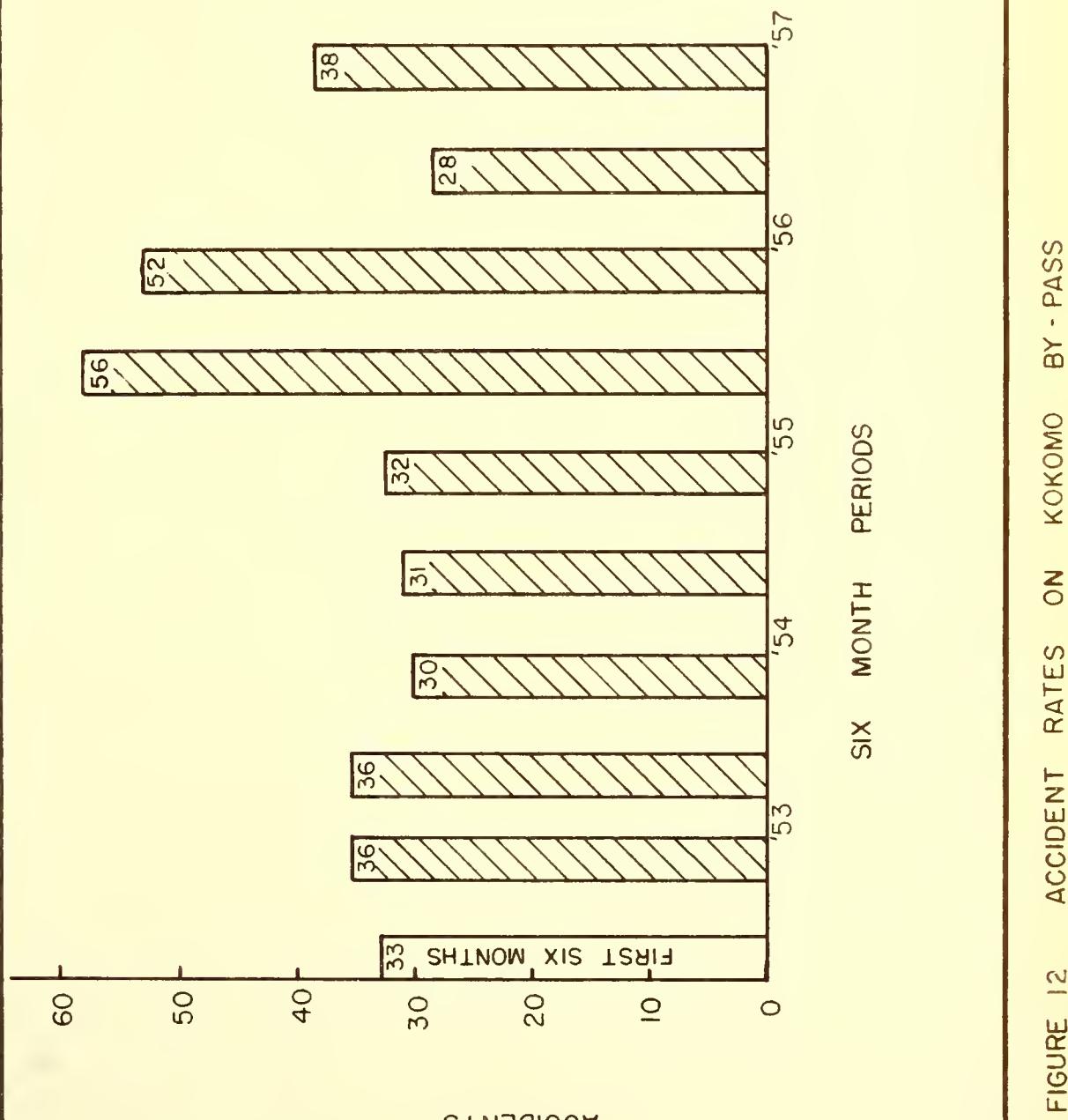
Table 1
CLASSIFICATION OF ACCIDENTS

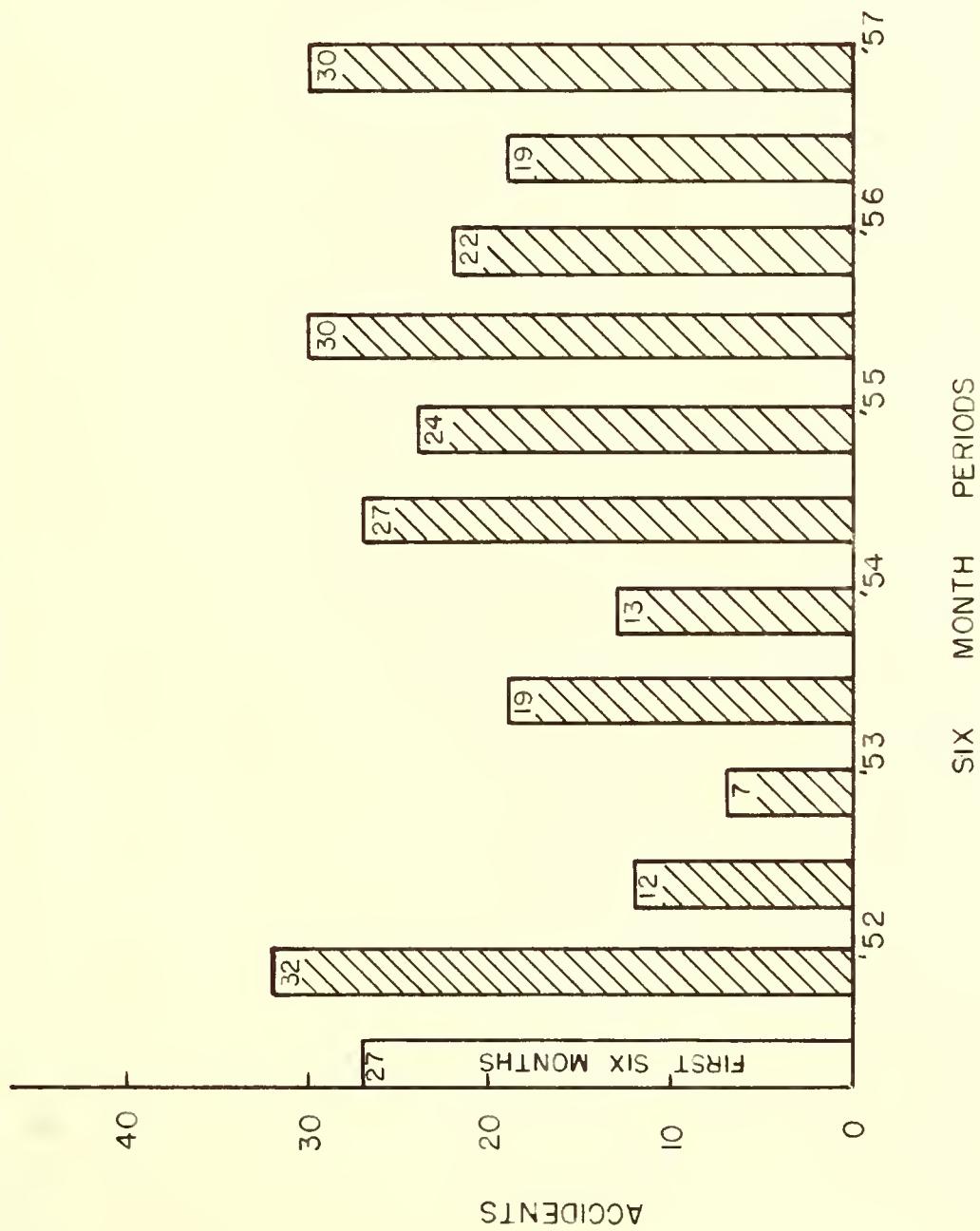
Kokomo By-Pass

	Classification			
	Type I	Type II	Type III	Type IV
Number of Accidents	118	106	44	71

Lebanon By-Pass

	Classification			
	Type I	Type II	Type III	Type IV
Number of Accidents	91	47	34	63





of accidents per six month period were thirty-eight on the Kokomo by-pass and twenty-one on the Lebanon by-pass. Totals for the last two and one-half years indicate, however, that these averages are rising.

The Type I and II accidents are directly related to the lack of access control on the two by-passes and could reasonably be termed "access accidents". Every street which is permitted access to the by-pass creates an intersection problem and all streets and drives with access to the by-pass cause the development of marginal accidents. In the remainder of this report, Type I and II accidents will be referred to as access accidents.

A visual indication of the accident problem which develops at access points to high speed by-passes is shown in Figures 14 and 15. On the Kokomo by-pass, 78 percent of the accidents studied occurred in a 3.25 mile section of the by-pass which had 43 access points, including five major streets, to the by-pass. Approximately 80 percent of these accidents were access accidents.

On the Kokomo by-pass, access accidents (Types I and II) accounted for a total of 224 accidents or 68 percent of the 339 accidents which occurred during the four and one-half year study period. Three of these accidents were fatal and the estimated property damage for the 224 accidents was \$118,700 or an average of \$26,400 per year.

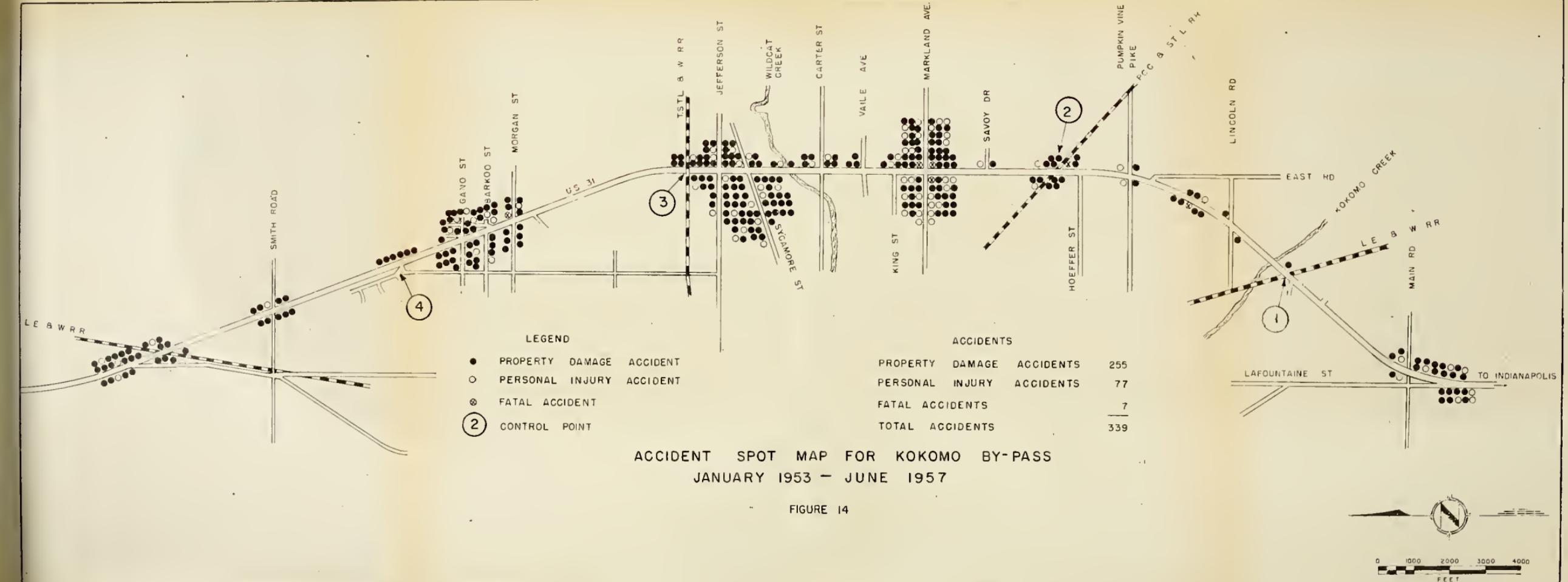
For the Lebanon by-pass, 138 or 59 percent of the 235 accidents studied were classed as access accidents. Four of these

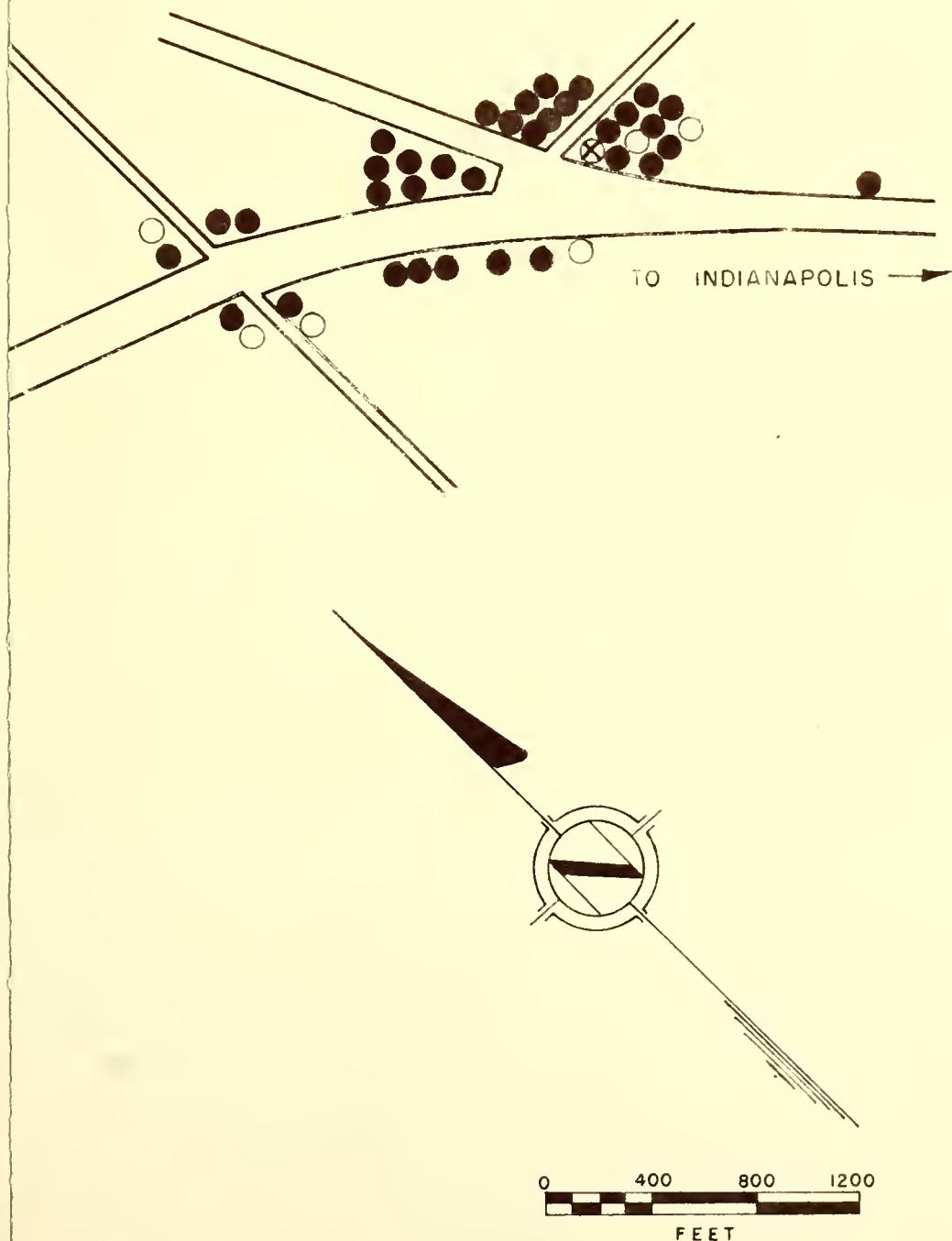
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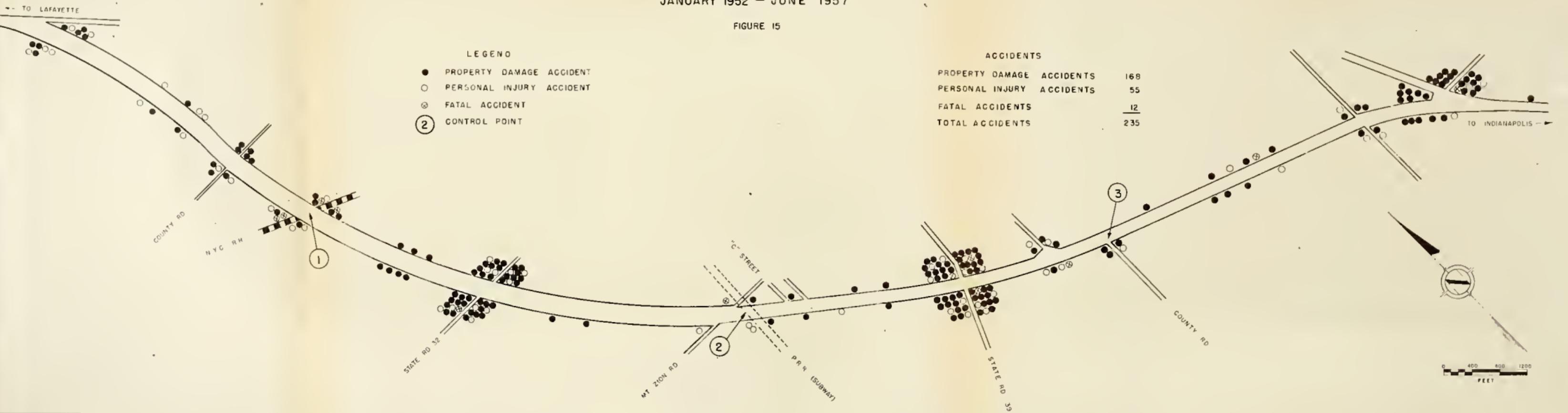
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ACCIDENT SPOT MAP FOR LEBANON BY-PASS
JANUARY 1952 - JUNE 1957

FIGURE 15



accidents were fatal and the estimated property damage totaled \$65,700 or an average of \$11,900 per year.

A comparison of the Kokomo and Lebanon by-passes indicates the effect of numerous access points and heavy use of a by-pass by local traffic upon the accident rate of the facility.

The Lebanon by-pass has a total of 29 access points and only two intersecting streets (S.R. 32 and 39) whose volumes are appreciable. These routes have average daily volumes in excess of 1650 vehicles per day but other streets entering the by-pass carry less than 400 per day. Use of the by-pass by local traffic is small and turning movements at by-pass intersections are light with the exception of the two intersecting state routes.

The Kokomo by-pass, however, has a total of 79 access points including six streets whose average daily traffic exceeds 1100 vehicles per day. The origin-destination "after" study, conducted in 1951, showed that the by-pass was being heavily used as a distributor street for local traffic. This produced many short local trips on the by-pass and heavy turning movements at the major streets. This local use has also been increasing due to the rapid development along the by-pass. The magnitude of this increase is indicated in Table 2.

Access accidents on the Lebanon by-pass have averaged approximately 25 per year while access accidents per year on the Kokomo by-pass are double that at an average of 50. These figures are

Table 2

TRAFFIC INCREASE ON LOCAL STREETS ENTERING BY-PASS
KOKOMO, INDIANA

Location		May, 1951	November, 1957
On	Near	Average Weekday Volume	Average Weekday Volume
Jefferson	By-pass	1312	1427
Sycamore	By-Pass	1886	4524
Hoffer	By-Pass	1484	1941
Boulevard*	By-Pass	—	3132
Markland	By-Pass	6313	7104

* Not open in 1951

even more significant when it is considered that the estimated average daily volume of through traffic for the study period on the Kokomo by-pass is 1410 vehicles per day while through traffic on the Lebanon by-pass for the same period was approximately 5130 vehicles per day. Thus, it can be seen that the volume of through traffic is not the problem but instead the volume of local traffic entering and leaving the by-pass at numerous access points.

Another example of the effect of local traffic upon by-pass accidents may be obtained by considering the rapid rise of accidents on the Kokomo by-pass during the second half of 1955 and the first half of 1956. Total accidents during these two periods increased 71 percent over those of the previous two periods and access accidents increased by 78 percent.

It was found that these two periods corresponded exactly with the time at which the Chrysler plant was completed and placed in operation. This plant generated large volumes of relatively new traffic which used the by-pass as a distributor street. This increased local use of the by-pass, no doubt, accounts for the rapid rise in by-pass accidents.

Figure 16 shows a comparison of the percentages of each type accident and Table 3 indicates the severity of each type of accident.

The lack of access control is also contributing indirectly to all types of accidents on the by-passes. The at-grade intersections

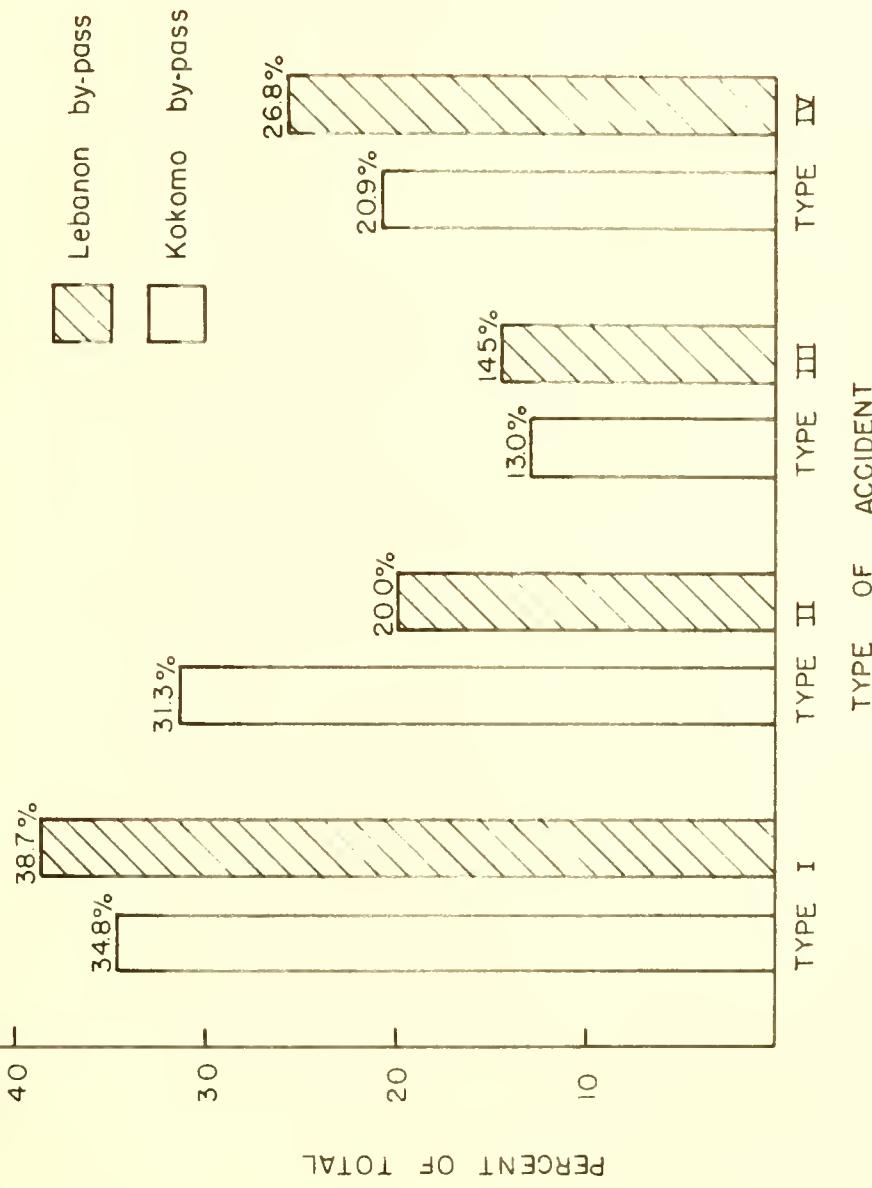


FIGURE 16 COMPARISONS OF ACCIDENT TYPES

Table 3

RELATIONSHIP OF TYPE AND SEVERITY OF ACCIDENT

Kokomo By-Pass

		Type			
		I	II	III	IV
Severity	Property Damage	91	78	36	50
	Personal Injury	25	27	7	18
	Fatal	2	1	1	3
	Total	116	116	44	71

Total Estimated Accident Damage - \$205,000

Access Accident Damage - \$115,700

Lebanon by-Pass

		Type			
		I	II	III	IV
Severity	Property Damage	60	40	20	43
	Personal Injury	20	6	6	14
	Fatal	3	1	6	2
	Total	71	47	34	63

Total Estimated Accident Damage - \$147,000

Access Accident Damage - \$65,700

and the numerous access points cause congestion and delay and as a result there is a considerable amount of variance in vehicle speeds over different sections of the by-passes (Figures 9 and 11). This variance in vehicle speeds creates conflicts and friction within the traffic streams and causes the development of many Type III and IV accidents.

Considering the figures in Table 1, it is apparent that a controlled access, multi-lane divided facility has a tremendous potential for eliminating accidents. It is reasonable that all accidents of the Types I, II, and III could be eliminated by such a facility. Thus, 79.1 percent of the accidents occurring on the Kokomo by-pass and 73.2 percent of those occurring on the Lebanon by-pass could be prevented by the construction of a modern controlled access facility.

In view of the travel-time studies and the accident rates, it appears that dual lanes are warranted on both by-passes. This is especially true of the Lebanon by-pass. Although only 34 medial accidents (Type III) have occurred on the Lebanon by-pass, they have been quite severe. Six of these accidents were fatal accidents in which a total of 14 persons were killed. All of these fatalities were head-on collisions and occurred along sections of the by-pass which had poor sight distance.

The junctions of both by-passes are causing some trouble (Figures 14 and 15) and an improvement in the design and operation of these junctions could prevent many unnecessary accidents.

The south junction of the Lebanon by-pass is a trouble spot and is greatly confusing the drivers. Many of the drivers commented in the accident reports that upon entering the junction from the south they suddenly thought that they were on the wrong side of a dual-lane highway.

The at-grade crossings of the railroads on the Kokomo by-pass, while being undesirable, are not creating serious delay or accident problems. Only a total of 12 accidents out of the 339 studied could be directly attributed to the railroad crossings.

Economic Considerations

One of the factors opposing the use of limited access facilities is the considerable extra initial cost that is required to provide access rights, frontage roads and construct grade separations and interchanges. This leads to the common hypothesis that these facilities cannot be economically justified unless volumes are unusually heavy. On the basis of this study, however, it appears that if enough through traffic exists to justify the construction of a by-pass, then the most economical facility would be a limited access one.

Most by-passes are economically justified by computing the benefits, in terms of time savings and reduced operating costs, that accrue to through motorists. The fallacy of this method,

with regard to nonlimited access facilities, is the assumption that the benefits obtained initially will be perpetuated for the life of the by-pass and the disregard of the operational characteristics of such facilities. As local traffic use and development along the nonlimited access by-pass increases, initial benefits to through motorists will be significantly reduced and accident rates and economic losses will increase at a drastic rate.

If motorists are willing to pay for time savings, it seems they should be equally willing to pay for reductions in traffic accidents and highway fatalities. There were 224 access accidents on the Kokomo by-pass and 138 on the Lebanon by-pass and it is reasonable that all these access accidents could have been prevented had the two by-passes been controlled access facilities. An indication of the economic loss involved in these access accidents is presented below.

The National Safety Council estimates the average economic loss due to a personal injury at \$950 and the average economic loss per fatality at \$21,800. Estimated property damages were obtained from the accident reports.

Kokomo By-Pass

4 deaths at \$21,800 each	-	\$ 87,200
52 personal injuries at \$950 each	-	49,400
Estimated property damage	-	<u>118,700</u>
Total		\$ 255,300

Kokomo By-Pass

$$\text{Average loss per year} = \frac{\$255,300}{4.5} = \$56,700$$

Lebanon By-Pass

5 deaths at \$21,800 each	-	\$ 109,000
26 Personal injuries at \$950 each	-	24,700
Estimated property damage	-	62,700
Total		<u>\$ 196,400</u>

$$\text{Average loss per year} = \frac{\$196,400}{5.5} = \$35,250$$

The elimination of these losses would justify large expenditures. Over a 25 year period at four percent interest, the annual savings would amount to \$885,900 for the Kokomo by-pass and \$56,400 for the Lebanon by-pass.

An even greater savings would be available if a controlled access, multi-lane divided facility were provided. This would have the potential of eliminating all Type I, II and III accidents. The losses due to these types of accidents on the Kokomo and Lebanon by-passes are computed below.

Kokomo By-Pass

5 deaths at \$21,800 each	-	\$ 109,000
59 Personal injuries at \$950 each	-	56,050
Estimated property damage	-	197,100
Total		<u>\$ 362,150</u>

$$\text{Average loss per year} = \frac{\$362,150}{4.5} = \$80,450$$

Lebanon by-pass

19 deaths at \$21,800 each	-	\$ 414,200
34 personal injuries at \$950 each	-	32,300
Estimated property damage	-	<u>103,500</u>
Total		<u>\$ 550,000</u>

Average loss per year = $\frac{550,000}{5.5}$ = \$100,000

The elimination of these losses would justify an expenditure of \$1,257,500 for the Kokomo by-pass and an expenditure of \$1,562,500 for the Lebanon by-pass.

ECONOMIC EFFECTS

Land Use

Land use along the Kokomo by-pass was studied for the following periods: (1) 1938 (Before by-pass), (2) 1948 (By-pass authorized), (3) 1951 (After opening of by-pass) and (4) 1957 (Present use).

Land use of the by-pass area in Kokomo for the year, 1938, is shown in Figure 17. This was approximately ten years before the by-pass was authorized and the area was essentially farm land. Some residential development was evidenced on the east edge of Kokomo and a small amount of business and residential units was located on U.S. 31 north and south of Kokomo.

Very little change in land use was noted from 1938 to 1948 when the by-pass was authorized. A low-class housing development north of Morgan Street had extended into the by-pass area and some residential construction had occurred east of the present by-pass. In addition, a few business units had been added on U.S. 31 south of Kokomo and along Markland Avenue in the vicinity of the by-pass. The land use for this period is shown in Figure 18.

There was considerable change in land use and an acceleration of activity in the by-pass area from 1948 to 1951. Land use in 1951, approximately six months after the opening of the by-pass, is shown in Figure 19.

The land at the intersection of Markland Avenue (S.R. 35)

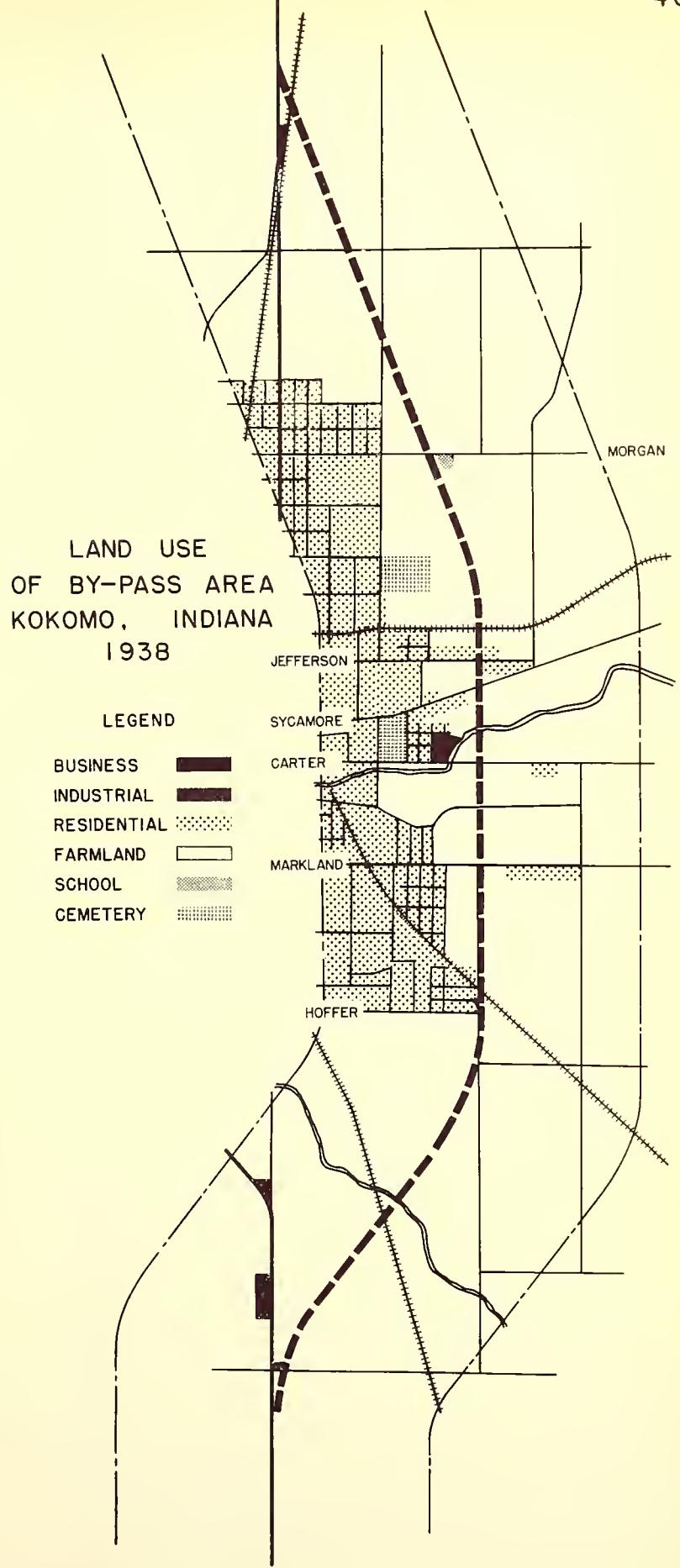


FIGURE 17

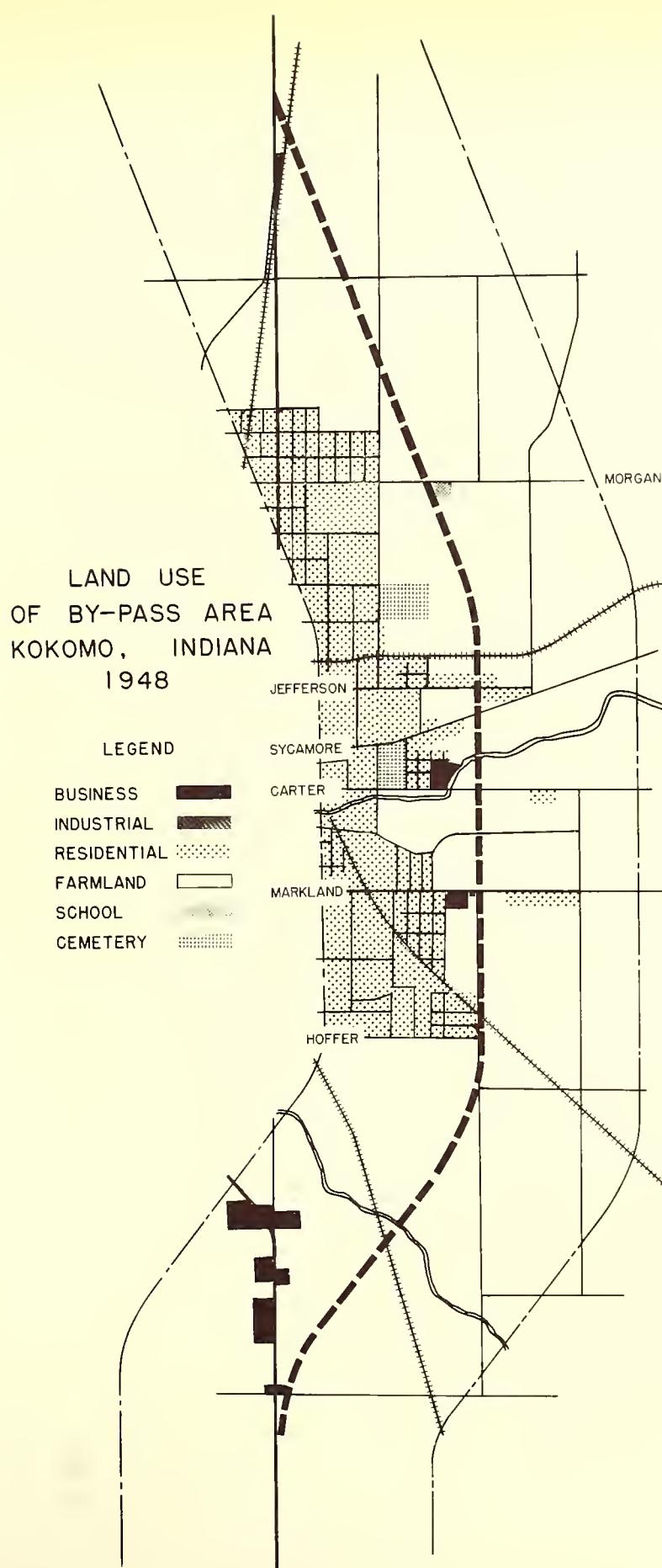


FIGURE 18

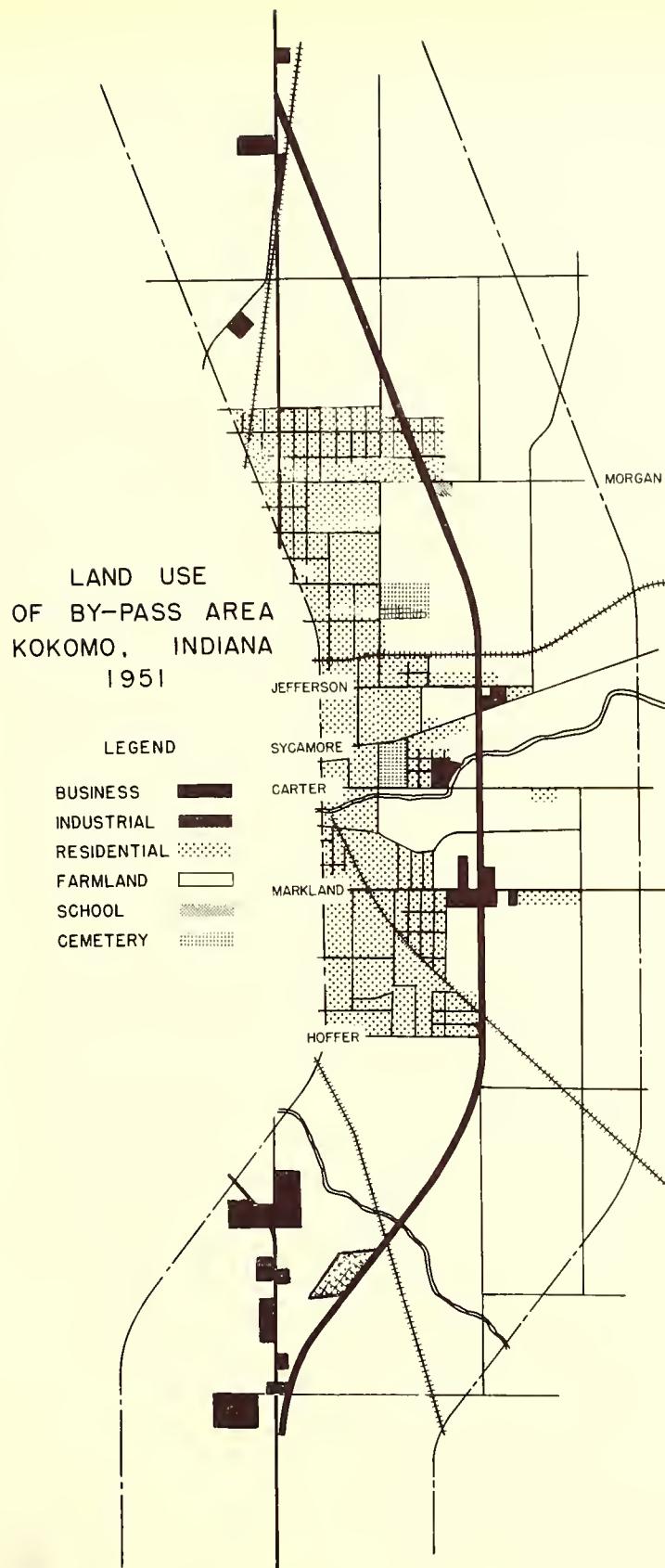


FIGURE 19

and the by-pass was immediately developed for business with five businesses going into operation on the by-pass and three more being added just west of the by-pass on Markland Avenue. Also, on each end of the by-pass additional businesses were in operation or under construction. Near the south junction, just south of Kokomo Creek, an expensive residential area was opened and five houses were completed or under construction at this time.

Figure 20 shows the land use of the by-pass area at Kokomo as of November, 1957. This land use, when compared to that of 1948, shows the very significant change that has occurred since the authorization of the by-pass. The pattern of farm land and low cost residential units, shown in 1948, has been supplanted by a more diverse and intensified pattern of industrial, business and high cost residential land use (Figure 21).

In 1955, Chrysler Corporation built a plant in the area south of Hoffer Street and north of Kokomo Creek. This plant (Figure 22), which manufactures Power Flite automatic transmissions, occupies some 800,000 square feet of floor space and employs approximately 3500 persons. There is little reason to doubt that the by-pass and the access it provided, was a determining factor in the location of this plant. The Pennsylvania Railroad Company owns an industrial tract just east of the Chrysler plant, which fronts on the by-pass, and there are indications that this area will also be developed for industrial

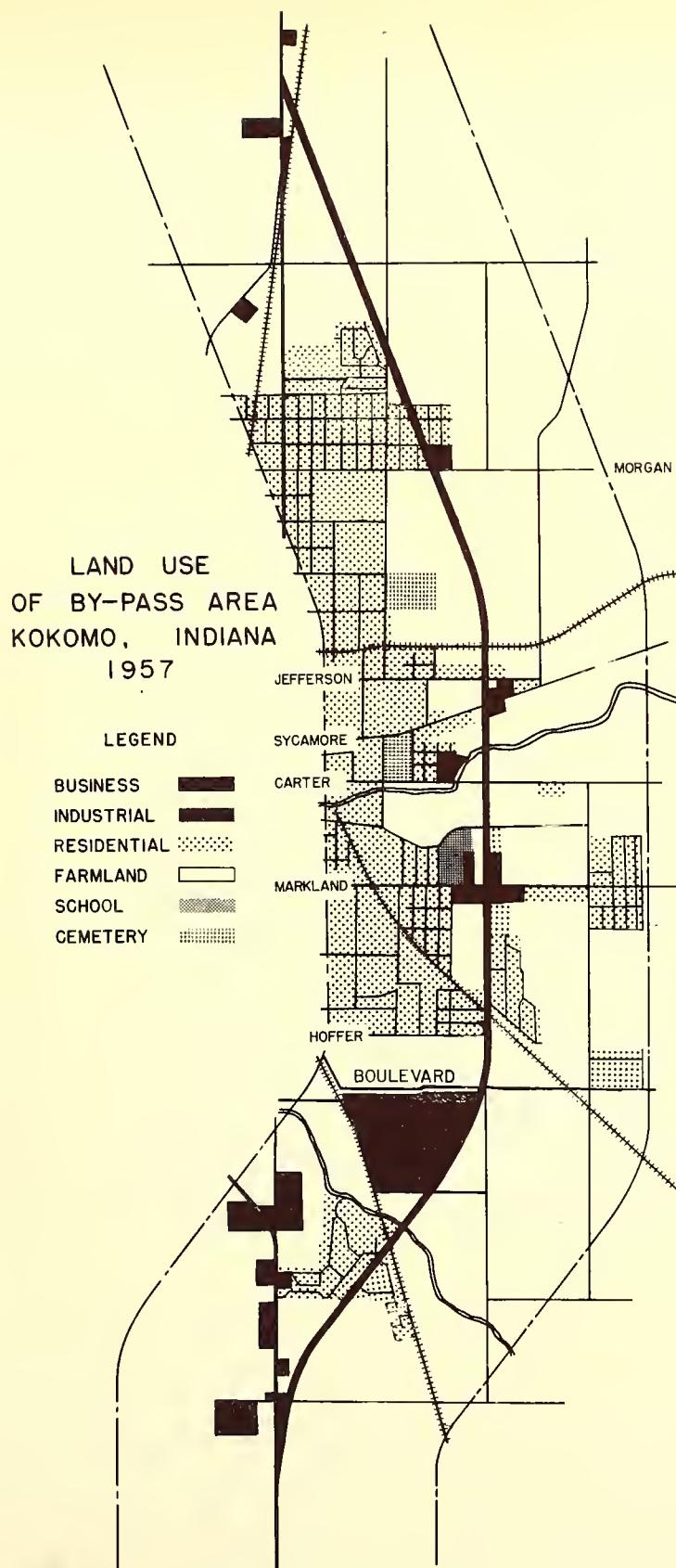


FIGURE 20



Figure 21. Business, Residential and Industrial
Land Use Along Kokomo By-Pass



Figure 22. Chrysler Plant on Kokomo By-Pass

use in the near future.

Residential development in the area of the Kokomo by-pass has greatly accelerated since the construction of the by-pass. The type of residential construction has also changed from a low-type residential unit to an expensive high-type residential unit.

In 1951, approximately six months after the opening of the by-pass to traffic, the only new housing development in the by-pass area was the Terrace Garden Subdivision with five houses under construction. Today, there are nine subdivisions in this area with provisions for 954 residences. The subdivisions and the number of platted lots are as follows:

Terrace Garden	142 lots
Terrace Garden Extension	
Rainbow Village	32 lots
Cedar Crest	205 lots
Cooks	48 lots
Bon-Air Crest	40 lots
Bon-Air School	142 lots
Hemwood Gardens	143 lots
Bellaire Gardens	202 lots

All of these subdivisions, with the exception of Cedar Crest, are from 90 - 100 percent complete.

Several of these subdivisions are fine residential areas. The Terrace Garden and Rainbow Village Subdivision, shown in Figure 23, are located just south of Kokomo Creek and have homes valued from \$20,000 to \$30,000. The Bon-Air Crest and



Figure 23. Terrace Garden and Rainbow Village
Subdivision on Kokomo By-Pass

55

Pon-Air School Subdivisions (Figure 24), located north of Morgan Street, have homes in the \$1,000 to \$15,000 range and the Cedar Crest Subdivision (Figure 25), which is presently under construction and located south of Maryland Avenue, will have homes in the \$15,000 to \$25,000 range.

At the present there are a total of 27 businesses in the by-pass area and 19 of these establishments front directly on the by-pass. A listing of these businesses by types is as follows:

3	Motels
2	Garages
8	Restaurants and Drive-ins
6	Service Stations
5	Used Car Lots
1	Grocery
1	Fix-it Shop
1	Home Garage Sales

-27-

Though the growth in the Kokomo by-pass area has been great, it has undergone an orderly development under the guidance of the Kokomo City-County Planning Commission. This group, in a sincere effort to preserve the by-pass for the movement of through traffic, has limited business development along the by-pass through a strict zoning ordinance. The by-pass area has been zoned essentially for residential use with business limited to the few locations shown in Figure 26. There is little doubt that a much more



Figure 24. Bon-Air Crest and Bon-Air School
Subdivisions on Kokomo By-Pass



Figure 25. Cedar Crest Subdivision

on Kokomo By-Pass

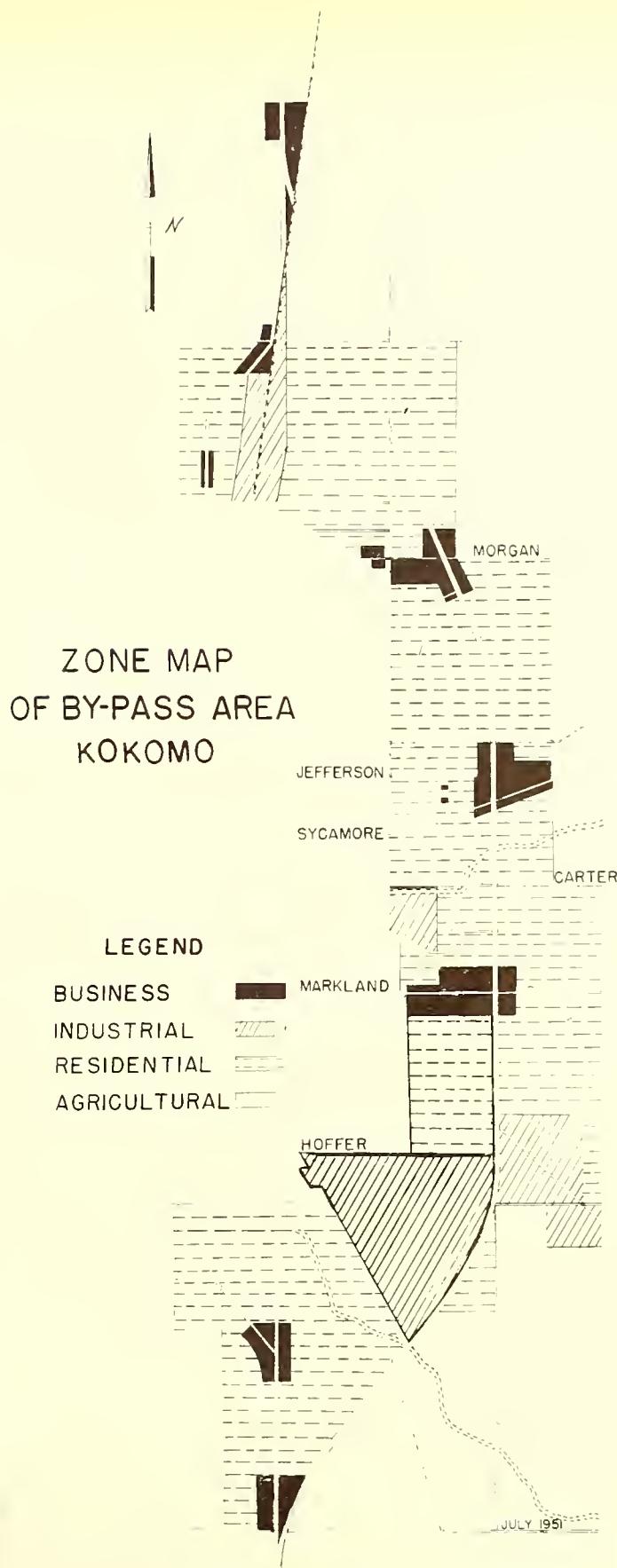


FIGURE 26

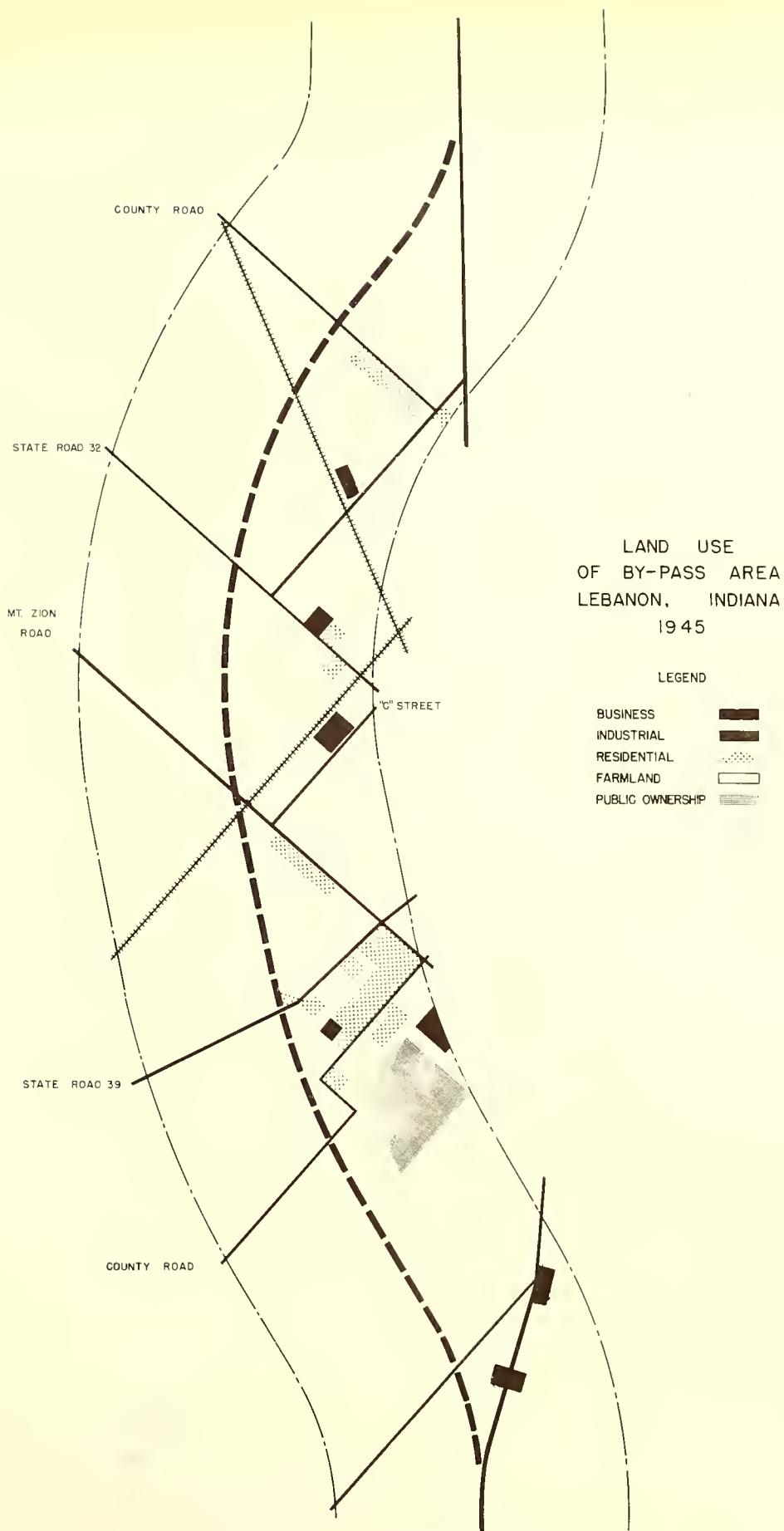
extensive and detrimental roadside business development would have taken place had it not been for this zoning.

The Planning Commission has also prevented the addition of numerous access drives by requiring the housing developments to use existing streets for access to the by-pass. This is shown in Figures 24 and 25.

The area along the Lebanon by-pass has experienced a much more limited development when compared to the area along the Kokomo by-pass. This is due, mainly, to the more static condition of Lebanon and to the location of the Lebanon by-pass which is separated from the developed area of Lebanon by an elevated railroad track.

In 1945, before the by-pass was considered, the land use was essentially farming as is shown in Figure 27. During the planning and construction of the by-pass in 1950, several businesses were started along the by-pass and were ready for operation when the by-pass was finished. The land use in 1950 is shown in Figure 28. The businesses established included three service stations, two restaurants and one motel.

After the early influx of business development to tap the transit trade, very little development occurred in the next year. The land use in 1951, as shown in Figure 29, indicated some small industrial development along State Route 32 east of the by-pass as the only change from that of 1950.



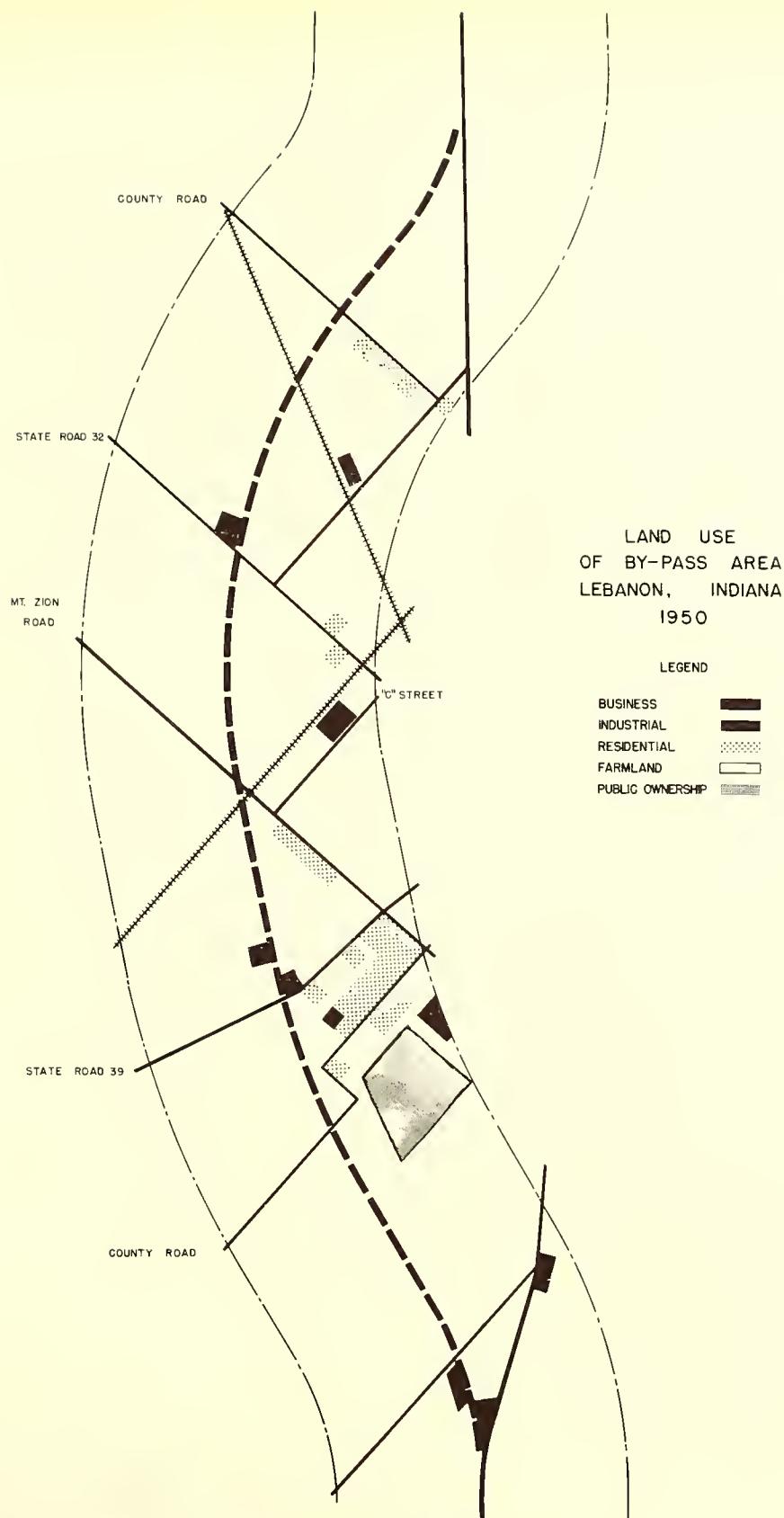


FIGURE 28

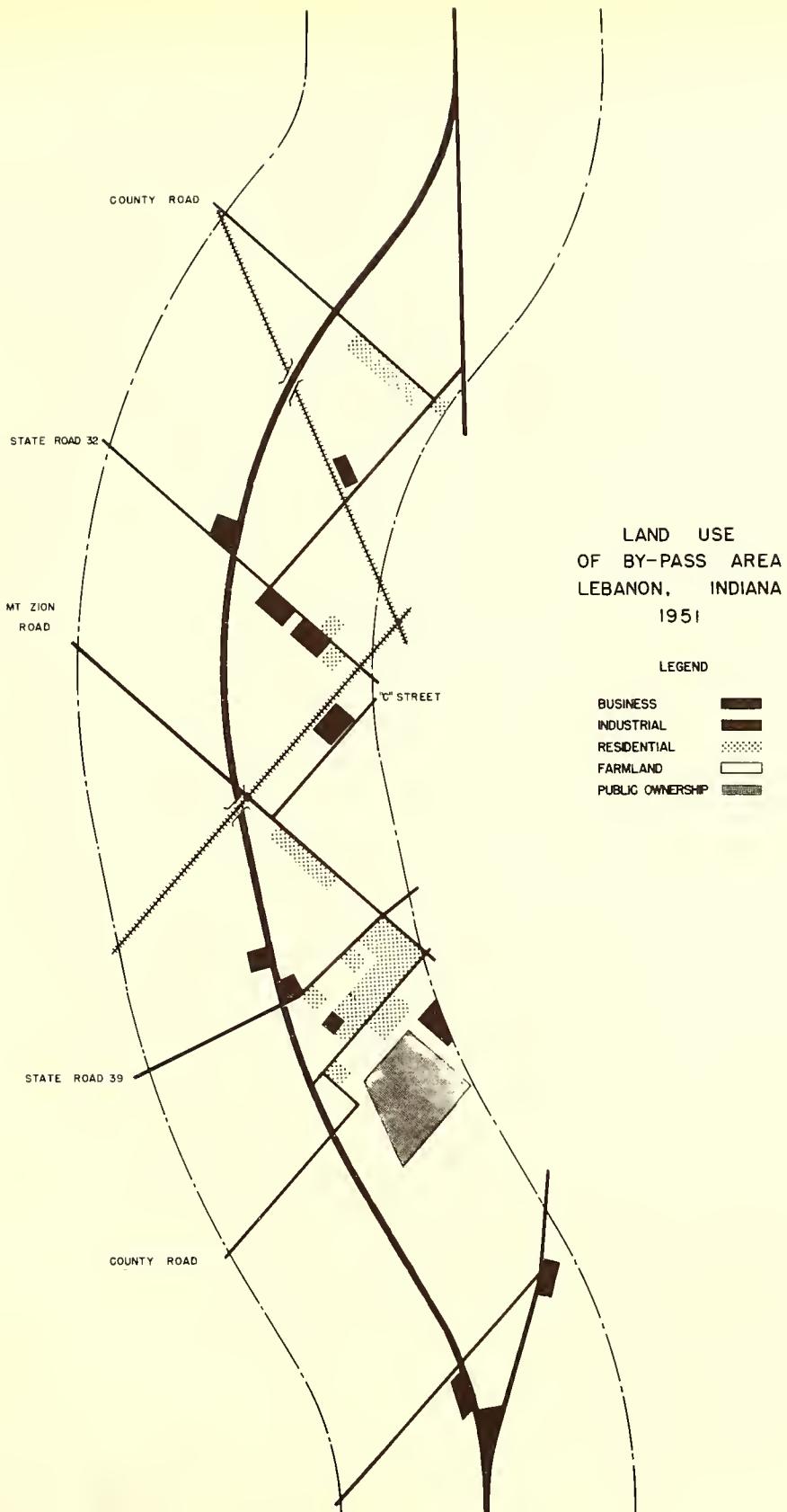


FIGURE 29

Present land use in the by-pass area is still essentially for business and farm use. Very little industrial or residential development has occurred since 1950. One new residential area has extended into the by-pass area but it is doubtful that it was influenced to any extent by the by-pass.

At the present, there are 12 businesses in operation along the by-pass. These include five service stations, three restaurants, two motels, one automobile dealer and one farm implement dealer. Present land use is shown in Figure 30.

Land Values

A major problem facing highway improvement programs today is that of right-of-way acquisition. Property owners everywhere are presenting huge but undocumented claims for loss of value and damage to their property caused by the construction of highway facilities. Data concerning the effect of a highway facility upon land values in its vicinity are vital to the proper evaluation of highway damages and benefits.

The land in the area of the Kokomo by-pass has undergone a significant change in land value and this change is closely related to the by-pass. Since land values can be affected by many factors, it would be impossible to evaluate the exact effect of the by-pass on land values. It was planned, therefore, that data would be accumulated and assembled in such a manner that an

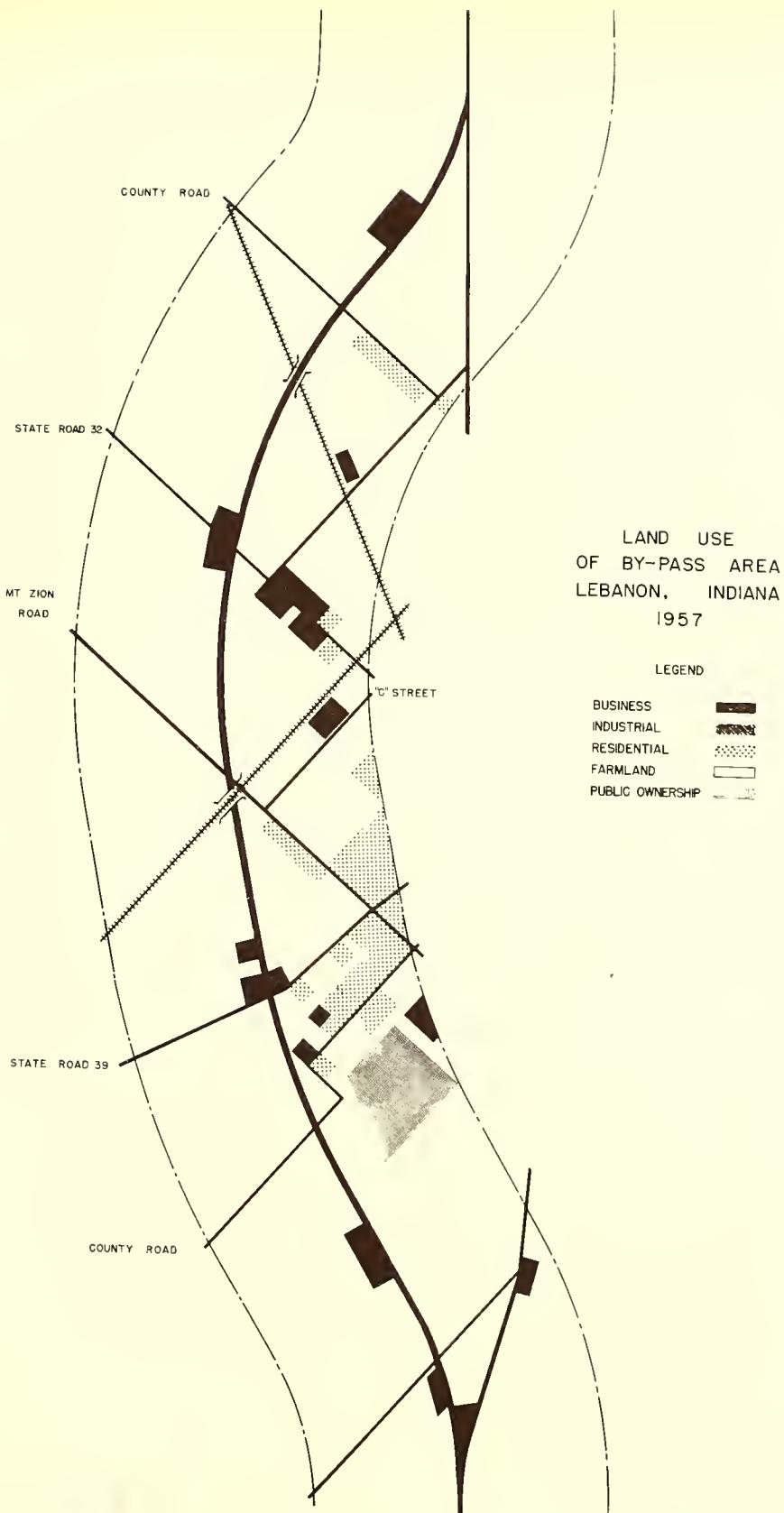


FIGURE 30

inference to the general over-all effect of the by-pass on land values could be readily made.

Kokomo has grown from a population of approximately 34,000 in 1940 to a population of 44,100 in 1956. It is reasonable that this growth and its inherent development would affect land values in the Kokomo area. In order to study this effect, a control area for which land values could be obtained was chosen in addition to the by-pass area. This area, shown in Figure 31, was not affected by the by-pass, but should reflect the effect of the population growth. Changes in land values for the by-pass area were then compared with changes in the control area for the same periods of time.

Three periods, 1938 - 39, 1948 - 49, and 1955 - 56, were used in the Kokomo land value study. This covers a period of time from approximately ten years before authorization of the by-pass to approximately six years after the opening of the by-pass to traffic. Values which are reported are for undeveloped land.

During the 1938 - 39 period, both the by-pass area and the control area were outside the city limits and were being used as farm lands. A study made in the Agriculture Economics Department at Purdue University reported that the average price of farm land in this area in 1941 was \$85 per acre. On the basis of these data and information supplied by real estate dealers, it was determined that a maximum price for the land under

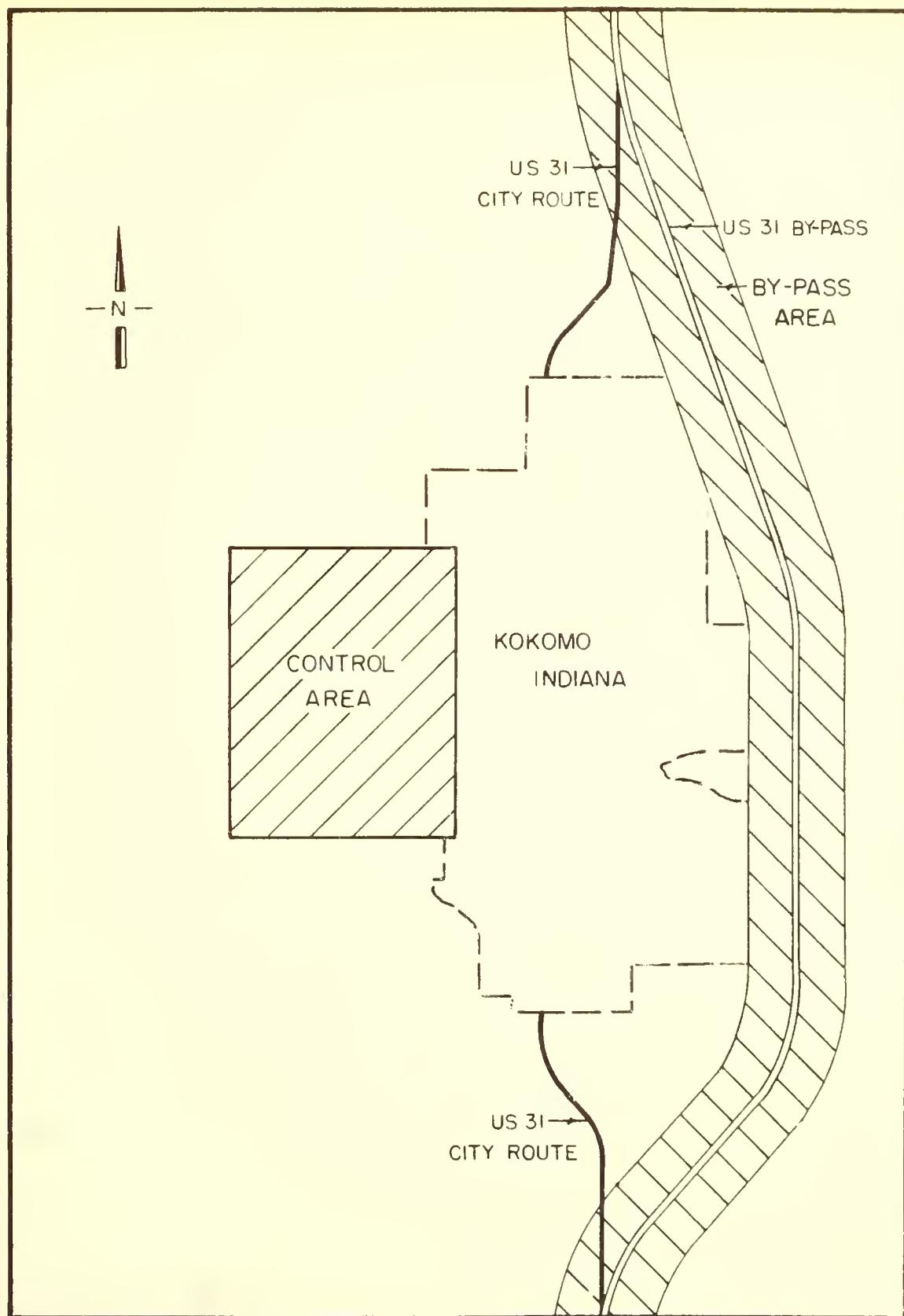


FIGURE 31 CONTROL AND BY-PASS AREAS
KOKOMO, INDIANA

consideration during this period would have been \$150 per acre.

The land value of the by-pass area in 1948 - 49 was reported in the previous study to have a top price of \$500 per acre. Little development had taken place in the area and the main demand for land was as low-class residential lots. The land in the control area, however, had undergone considerable change from 1939 to 1949 and was being developed as a fine residential area. Real estate dealers were quite familiar with sales in this area and were able to give considerable information regarding land values in the area. From this information, the average value of undeveloped land in this area for the 1948 - 49 period was determined to be \$1250 per acre.

Numerous land transactions took place in both the control area and the by-pass area during the 1955 - 56 period since development in both areas was accelerated during this time. Reported sale prices on large transactions in both areas were obtained.

An analysis of the sales data obtained from the real estate dealers indicated an average value of \$1850 per acre for undeveloped land in the control area and \$1700 per acre for similar land in the by-pass area. These values represent the sale of approximately 200 acres in the control area and approximately 240 acres in the by-pass area.

Land values for the control area and the by-pass area for

all three periods are tabulated in Table 4. In order to eliminate the effects of inflation, the land values were adjusted by deflation factors and to facilitate the comparison of land value changes, a final column shows all values computed as a percentage of 1948 - 49 values.

The figures indicate that land values in the control area increased 580 percent since 1930 while land values in the by-pass area increased 534 percent during the same period.

A good indication of the by-pass effect can be obtained by comparing the value of the separate properties expressed as a percentage of their 1948 - 49 value for the three different periods. This is shown graphically in Figure 32. From 1938 to 1949, the value of the control property increased 75.1 percent while the by-pass property increased 45.1 percent. From 1950 to 1956, the period during which the by-pass was constructed and placed in operation, land value in the control area increased 27.5 percent while that of the by-pass property increased 192.9 percent. Thus, it seems there is little doubt that the effect of the Kokomo by-pass has been to significantly increase land values in its vicinity.

The preceding data were mainly obtained from the sale prices of large undeveloped tracts as it was felt that this would give a better picture of average over-all land values. Small tracts in choice locations have been sold for much higher prices in both areas.

Table 4

TABULATION OF LAND VALUE

AREA	PERIOD	ACTUAL LAND VALUE	DEFLATION FACTOR	ADJUSTED LAND VALUE	PERCENT OF 1938-39 VALUE
Control	1938-39	\$150	1.72	\$258.0	21.9%
By-Pass	1938-39	\$150	1.72	\$258.0	54.7%
Control	1948-49	\$1250	0.94	\$1175.0	100.0%
By-Pass	1948-49	\$500	0.94	\$470.0	100.0%
Control	1955-56	\$1850	0.61	\$11498.5	127.7%
By-Pass	1955-56	\$1700	0.61	\$1377.0	292.9%

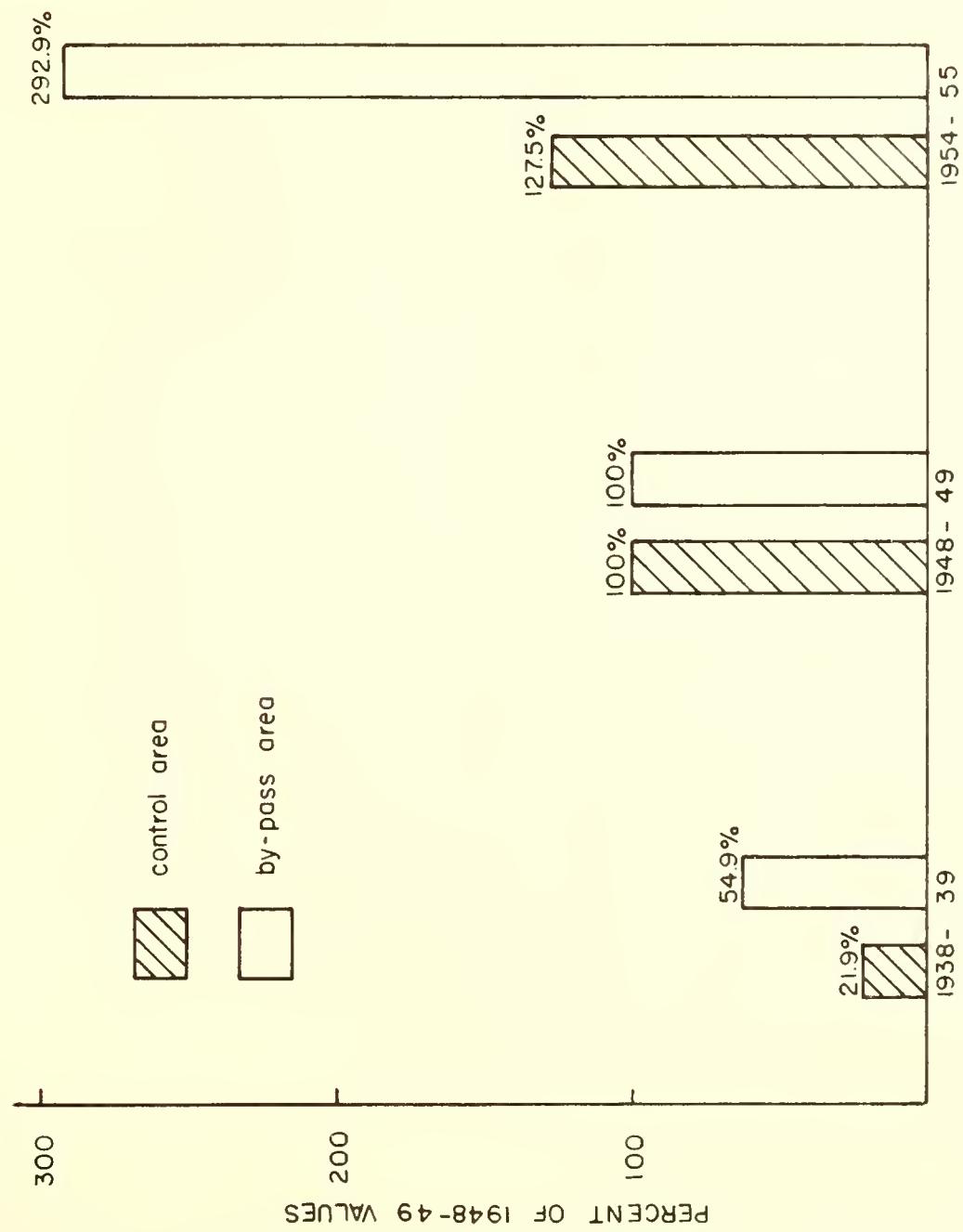


FIGURE 32 COMPARISON OF LAND VALUES KOKOMO BY-PASS

Residential lots in the control area are selling for approximately \$2100 each which includes the cost of streets, sidewalks, sewer systems and provisions for utilities. Lots in the Terrace Garden Subdivision along the by-pass sell for \$2500 per lot. These lots are large but are undeveloped. Lots in the Bon-Air Crest and Bon-Air School Subdivisions are valued at approximately \$1800 per lot. Also, two sales of \$15,000 each were reported for choice business locations on the by-pass.

Very little comprehensive data on land values could be obtained for the Lebanon by-pass. A number of real estate dealers were contacted, but they were unable to furnish a sufficient amount of information. A majority of the transactions took place when the by-pass first started and most of these were handled by individual property owners rather than by real estate firms.

A search of the records in the County Recorder's office revealed eight recent transactions of land in the by-pass area. The average sale price, as indicated by the amount of revenue stamps on the warranty deeds, was approximately \$1000 per acre. Also, a few sales of choice business locations were reported at a selling price of approximately ten thousand dollars each.

Since the by-pass area was valued as farm land prior to the construction of the by-pass, it is reasonable to say that land values in this area have increased at least 300 percent since the construction of the by-pass.

Business

Recent studies in California have shown that opinion surveys produce very little factual data and their results can be very biased (3). However, since a more factual method was not available and since the opinion of people in a community is what the highway administrator must often deal with, it was felt that an opinion survey might be of some value in evaluating business effects.

In Lebanon a total of 34 businessmen were contacted. The majority of these businesses were located on the old city route 52 through town but a few were located within one block of it around the courthouse square. All those interviewed had conducted their business before and after the by-pass was constructed.

The results of the Lebanon survey are shown in Table 5 and an analysis of the data is shown in Table 6.

All service stations and restaurants in Lebanon reported a decrease in business as might be expected since they depend to a great extent on the transit trade. Probably the most significant indication of this survey is the fact that only thirty-two percent favored the by-pass when it was proposed while sixty-five percent indicated that they now favor the by-pass. This is an indication that the benefits of reduced congestion were very evident after construction of the by-pass.

A large degree of transposition was noted among the businesses

TABLE 5 SUMMARY OF BUSINESS INTERVIEW
LEBANON, INDIANA

TYPE OF BUSINESS	TOTAL NUMBER INTERVIEWED	DID BY-PASS AFFECT BUSINESS			BUSINESS EFFECT			IN FAVOR OF BY-PASS			NOW			
		YES	NO OPINION	NO DECREASE	INCREASE	NO OPINION	YES	NO OPINION	NO OPINION	YES	NO	NO OPINION		
SERVICE STATION	14	7	0	0	7	0	0	0	2	2	3	4	3	0
RESTAURANT	5	3	0	0	3	0	0	0	0	1	2	1	2	0
SHOE STORE	3	3	0	0	0	3	0	2	1	0	3	0	0	0
HARDWARE	4	4	2	2	0	1	1	2	1	0	3	4	0	0
CLOTHING	6	5	1	2	2	0	0	5	3	2	0	5	0	0
DRUG STORE	4	3	2	1	0	2	0	1	1	2	0	1	2	0
HOTEL	1	1	1	0	0	1	0	0	0	1	0	0	1	0
OTHER	15	8	3	4	1	3	0	5	2	3	3	4	2	2
TOTALS	52	34	22	9	3	17	4	13	11	12	11	22	10	2

Table 6

ANALYSIS OF BUSINESS INTERVIEW
LEBANON, INDIANAQuestion - Did the by-pass affect your business?

Yes - 65% No - 26% No Opinion - 9%

Question - How did by-pass affect business?

Decrease - 50% Increase - 12% Undecided - 35%

Question - Did you favor the by-pass when it was proposed?

Yes - 32% No - 35% No Opinion - 33%

Question - Do you favor the by-pass now?

Yes - 65% No - 29% No Opinion - 6%

contacted in Kokomo. Out of a total of sixty-eight businesses that were contacted, only thirty-three of these businesses were operated by the same ownership as before the by-pass was built. Twenty-seven had changed ownerships and eight were entirely new businesses. The results of the Kokomo interviews are shown in Table 7 and an analysis is presented in Table 8.

Service station business seems to have suffered little in Kokomo as a result of the by-pass. Three service station owners were firm in the conviction that the by-pass had increased their business and those that reported business decreases termed them slight.

Considering the discussions with businessmen in both Kokomo and Lebanon and the results of the interviews, it seems apparent that business in both communities has not been adversely affected by the by-passes. With the exception of some service station operators and restaurant owners in Lebanon, most of the decreases reported were termed small and of little significance in the over-all economic picture.

Prevalent comments made by businessmen during the course of the interviews are listed in Table 9.

TABLE 7 SUMMARY OF BUSINESS INTERVIEW
KOKOMO, INDIANA

TYPE OF BUSINESS	NUMBER CONTACTED	OPERATE BEFORE BY-PASS	NEW OWNER BY-PASS	BUSINESS EFFECT				IN FAVOR OF BY-PASS				NOW				
				DID BY-PASS AFFECT BUSINESS		WHEN PROPOSED		YES		NO OPINION		YES		NO OPINION		
				YES	NO OPINION	NO DECREASE	INCREASE	NO OPINION	YES	NO OPINION	YES	NO OPINION	YES	NO OPINION	NO OPINION	
SERVICE STATION	28	8	14	6	8	0	0	5	3	0	2	5	1	2	5	1
GARAGE	6	4	2	0	2	2	0	2	0	2	2	2	0	3	1	0
GROCERY	5	2	2	1	1	0	0	0	1	1	2	0	0	2	0	0
CAFE	6	3	2	1	3	0	0	3	0	0	0	3	0	0	3	0
TOURIST HOME	3	3	0	0	3	0	0	3	0	0	0	3	0	1	2	0
LIQUOR	5	2	3	0	0	2	0	0	0	0	2	2	0	0	2	0
OTHER	15	11	4	0	2	9	0	1	1	9	10	0	1	10	0	1
TOTALS	68	33	27	8	19	14	0	14	5	14	18	13	2	20	11	2

Table 8

ANALYSIS OF BUSINESS INTERVIEW
KCKOMC, INDIANA

Question - Did the by-pass affect your business?

Yes - 58% No - 42% No Opinion - 0

Question - How did the by-pass affect business?

Decrease - 74% Increase - 26% Undecided - 0

Question - Did you favor by-pass when it was proposed?

Yes - 55% No - 39% No Opinion - 8%

Question - Do you favor the by-pass now?

Yes - 61% No - 33% No Opinion - 6%

Table 9

COMMENTS ABOUT BY-PASSES

Removal of through traffic and congestion was necessary.

By-pass should have had dual lanes.

By-pass is death trap.

Access should be restricted so that businesses couldn't locate on by-pass.

City streets should have been widened and route brought through town.

By-pass will be needed to by-pass the by-pass.

SUMMARY OF RES L15

The following summary of results is made from this study:

1. Average over-all travel time on the Lebanon by-pass has increased 17.5 percent since 1951, causing a 25.7 percent reduction in time savings to through traffic.
2. Average over-all travel time on the Kokomo by-pass has increased very little but significant increases are likely within a short time.
3. Accident studies indicated a serious operational inefficiency on both the Kokomo and Lebanon by-passes and that the lack of access control is a major cause of the accidents. Sixty-eight percent of the accidents on the Kokomo by-pass and fifty-nine percent of those on the Lebanon by-pass were attributable to the lack of access control on these facilities.
4. Control of access and the provision of a multi-lane divided facility would reduce accidents by approximately seventy-five percent on each of the by-passes. A multi-lane divided facility is greatly needed on the Lebanon by-pass and is highly desirable on the Kokomo by-pass.
5. Over a 25 year period, the elimination of access accidents would justify expenditures of \$685,900 on the Kokomo by-pass and \$566,400 on the Lebanon by-pass to provide the necessary control of access.
6. Land use in the vicinity of both by-passes has been significantly affected. This effect is more pronounced along the

Kokomo by-pass where extensive residential, business, and industrial development has occurred. Development along the Lebanon by-pass has been mainly limited to businesses which cater to the transit trade on the by-pass.

7. Land values have greatly increased in the vicinity of both by-passes since their construction and this increase is directly related to the by-passes. Land values along the Kokomo by-pass increased 192.9 percent since the construction of the by-pass while land values of unaffected control properties in Kokomo increased 27.5 percent during the same period.

8. Results of the business survey indicated that the by-passes had little adverse affect on business in Kokomo and Lebanon.

9. The knowledge of economic effects should be broadened by future studies of limited access facilities when the opportunity becomes available.

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